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In this issue

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Collecting mosquitoes in a Trinidad rain forest for the Rockefeller Foundation's virus research program. Photograph from the Rockefeller Foundation Annual Report, 1954.

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Relationships of health to demographic characteristics warrant further examination and study in the United States.

Some Problems for Research in Mortality and Morbidity

By HAROLD F. DORN, Ph.D.

THE COLLECTION, compilation, and publication of vital statistics are among the major activities of every public health agency. Too frequently the collection and preparation for publication of vital statistics require such a large proportion of the time and energy of available personnel that the analysis and interpretation of these data are neglected. Yet without analysis and interpretation, vital statistics remain relatively sterile.

Nearly a century ago the great English vital statistician, William Farr, began his analysis of official mortality records in order to discover and point out significant variations in ill health among various groups of the population. The work he initiated has been continued and expanded by succeeding registrars general. The most extensive information concerning variations in mortality rates by occupation and socioeconomic classes available anywhere is that for England and Wales.

The United States does not have a series of analyses of mortality statistics comparable to those of England and Wales. The first third of this century was devoted to establishing a complete registration system covering the entire United States. Mortality and natality statistics for the entire country first became available in 1933.

A test of birth registration completeness made at the time of the 1950 census of population revealed that a birth certificate was on file for 98.6 percent of white infants and for 93.5 percent of nonwhite infants born during the first quarter of 1950.

Although a comprehensive study of the completeness of death registration has never been made, the relative amount of under-registration probably is negligible except for some rural areas whose aggregate population is not large. The relative amount of under-registration of infant deaths may be somewhat greater than that for deaths of persons aged 1 year or older. In computing the 1939–41 life tables, the National Office of Vital Statistics assumed that the relative under-registration of infant deaths was approximately equal to that of births. However, this assumption has never been tested by an actual field study.

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Rural and Urban Differences in Mortality

One of the first illustrations of mortality differences in medical literature was the higher death rate among city dwellers in contrast to rural residents. Although this difference gen-

erally is assumed to exist at the present time, no comprehensive study of the problem has been made in recent years.

Mortality statistics classified by the place of residence of the deceased were first published by age, sex, race, and size of community for deaths occurring in 1940. These were available for each State for all causes combined and for a limited number of important causes for both sexes combined for the entire United States. A supplementary volume (*1*) presented data for the 2-year period, 1939–40, for each city of 100,000 or more population, by leading causes of death, age, and race and for each county and city of 10,000 or more population for all causes. By the time these data were published in 1943, World War II was in progress so that a systematic analysis of the 1940 mortality tabulations was not conducted.

Two important changes affecting the use of mortality statistics were introduced in the 1950 census of population: the change in the definition of the urban population to include the urban fringe of cities of 50,000 or more population and the delineation of standard metropolitan areas and standard economic areas and regions. Prior to and including 1930, urban was defined as places of 10,000 or more inhabitants in the tabulation of vital statistics, a definition that did not correspond to that used in the census of population from 1910 to 1940. In 1940, for the first time, a comparable definition of urban and rural population was used for both the enumeration of population and the tabulation of vital statistics. No practicable way of classifying vital statistics in accordance with the revised definition of urban population used in the 1950 census has yet been devised, so once again it appears that the definition of the urban population may not be the same for the two sets of statistics.

Fortunately, a reasonably satisfactory substitute for the rural-urban classification is available. Since 1950, the National Office of Vital Statistics has tabulated mortality statistics for the metropolitan and nonmetropolitan counties of each State. In general, metropolitan counties are the counties included in the standard metropolitan areas used by the Bureau of the Census. No extensive analysis of these statistics has yet been published.

Geographic Variations in Mortality

Almost a century ago, William Farr proposed that the healthiest districts of England and Wales be used as a yardstick of public health. From time to time since then, the registrar general has used this concept in the presentation and analysis of mortality data. In contrast, very little has been published in the United States concerning geographic variations in mortality rates. The range between the States with the highest and lowest mortality rates probably has been decreasing. Nevertheless, in 1950, after adjusting for differences in the age composition of the population, the highest rate still was 40 percent above the lowest rate.

State death rates by age vary much more than the average rate for all ages. For the white population in 1950, the highest rates for each age group under 55 years were approximately twice as large as the lowest rates. Above this age the range in death rates is smaller but still averages about 50 percent.

The range between the highest and lowest death rates almost certainly would be greater for areas smaller than States. The county is the preferable unit for forming such areas since the basic demographic data are available for counties and since the allocation of deaths to county of residence undoubtedly is more reliable than the allocation to rural or urban areas.

Two groupings of counties suggest themselves: metropolitan and nonmetropolitan counties within each State and the State economic areas or subregions defined by the Bureau of the Census in cooperation with other agencies. The economic subregions, although they cross State boundaries, are probably the most useful grouping of counties for the study of geographic differences in mortality rates. As no tabulation of mortality data by economic subregions has been made, a complete retabulation for one or more years around 1950 would be required.

Mortality by Occupation

The 14th Annual Report of the Registrar General of England and Wales for 1851 contained a tabulation of the deaths of males, aged 20 years or more, classified by the occupation of

the deceased. This was the first of a series of decennial reports that has been continued for 100 years. Shortly after the death registration area was established in the United States, plans were made for a study of occupational mortality around the date of the 1910 census. The 1909 volume of mortality statistics contains tables giving the number of deaths of males classified by age, occupation and cause of death. No data were published for subsequent years and so far as I can determine no analysis was ever made. A special tabulation of the census population by occupation would have been required since the death registration States of 1910 included only 51 percent of the total population of the United States.

The many discussions of the relationship of mortality rates to occupational and socioeconomic groups that have taken place in the United States since 1910 have produced few statistics. The National Tuberculosis Association published a brief analysis of mortality rates for 7 broad social and occupational classes, based upon the deaths of male workers in 10 States during 1930. Except for this study, no analysis of mortality differences among occupational or socioeconomic groups based upon official death statistics has been made in the United States.

One of the major deterrents to a study of occupational mortality has been uncertainty concerning the degree of comparability of the entries of occupation and industry on death certificates with those on the census of population schedules. A corresponding uncertainty also has prevented the analysis of official birth statistics by occupational or socioeconomic groups.

Fortunately, studies are now under way to resolve this difficulty. The Scripps Foundation in cooperation with the Bureau of the Census is planning to compare the entries for occupation and industry on a sample of birth and death certificates with corresponding information from the 1950 census schedules. In the meantime, the National Office of Vital Statistics is preparing an analysis of mortality differentials by occupation and socioeconomic class based on deaths of males from 20 to 65 years of age during 1950. The successful completion of these two projects will provide a basis for planning future studies of the relationship of mortality and fertility to occupational and socioeconomic classes in the United States.

Fetal Mortality

The rapid decline in the infant mortality rate has led some to assume that mortality during the first few months of life is now under control and that it is only a question of time until the death rate at the start of life will be lowered to the irreducible minimum. This is far from being the case. The high infant mortality rates of the past have distracted attention from the even higher fetal mortality rate. In addition, the reporting of fetal deaths has been so incomplete that a reliable estimate of fetal mortality could not be made.

In the United States, New York City probably has the longest record of registration of all fetal deaths regardless of the duration of pregnancy. In 1900 the reported infant mortality rate for New York City was 135 per 1,000 live births, and the reported fetal death rate was 45 per 1,000 live births plus fetal deaths. In 1953 the corresponding rates were 24 and 107 respectively. The increase in the fetal death rate from 45 to 107 per 1,000 probably is largely the result of improved reporting and the revision of regulations to specify more clearly that all fetal deaths, irrespective of the period of gestation, should be reported.

Registration still is seriously incomplete; during the 5 years from 1949 to 1953 the fetal death rate in New York City increased from 84 to 107 or about 27 percent. Studies of selected groups of pregnant women indicate that perhaps as many as one-half of the total fetal deaths are not reported. If generally true, this conclusion leads to an estimate that approximately 20 percent of pregnancies in New York City terminate in a fetal death and 80 percent in a live birth. Of the live births, between 2 and 3 percent die during the first year of life. In total, probably from 20 to 25 percent of pregnancies terminate either in a fetal death or in a live birth that fails to survive the first year of life.

This problem has been recognized by the World Health Organization, which has recommended that the term "stillbirth" be abandoned, and that all fetal deaths, irrespective of dura-

tion of pregnancy, be registered. Many years will be required before this recommendation can become generally effective since existing legal definitions of stillbirths must be changed and physicians must be convinced of the necessity of reporting every fetal death. It would be visionary to expect that the registration of fetal deaths, especially for pregnancies terminating after only 1 or 2 months, will ever be as complete as the reporting of infant deaths. Nevertheless, the experience in New York City is an illustration of what can be accomplished.

In the meantime, a new measure, the perinatal mortality rate, is beginning to be used. This is computed by dividing the sum of the number of infants dying during the first week or month of life and the number of fetal deaths during the last 4 or 5 months of pregnancy by the number of live births plus the number of fetal deaths included in the numerator.

In addition to the problem of developing a reliable measure of fetal mortality is that of obtaining information concerning the causes of fetal death. This is more complicated and difficult than obtaining information concerning the causes of infant deaths since death may be the result of conditions affecting the mother as well as the fetus. Moreover, medical information concerning the cause of death of fetuses has long been very inadequate. Plans are being made to develop better reporting of the causes of fetal death, but rapid progress should not be expected.

Mortality Rates by Sex

Existing data show that males experience a higher mortality rate from the early months of intra-uterine life until the end of the natural life span. Fragmentary data from genealogical records of ruling families indicate that males experienced higher mortality rates than females as long ago as the 15th century. In some countries and among some classes of the population, mortality rates have been higher for females than for males from about 15 to 30 years of age. This has been particularly true where mortality rates have been relatively high compared with those existing at present. As late as 1925 in the United States, the death rate for ages 15 to 34 years was practically as high for females as for males. Since then the rate for males has exceeded that for females at every age.

The excess mortality among males has increased as the level of the death rates has fallen. In 1900, the age-adjusted death rate for white males was 10 percent higher than that for white females. By 1950 this difference had increased to 48 percent, and there is no indication that it may decrease in the near future.

The difference between the male and female mortality rates is now large enough to warrant an attempt to discover an explanation. To what extent is it the result of greater occupational hazards experienced by men? How much of the difference may be attributed to biological differences? The ratio of mortality rates for the two sexes is in striking contrast to the ratio of morbidity rates. Although morbidity data are rather inadequate, most studies report higher rates for females than for males.

Mortality During Old Age

Not only has the decline in mortality rates for every age among males in the United States failed to keep pace with the decline in mortality rates among females, but the decline in mortality rates for males more than 40 years of age in the United States also has not kept pace with the corresponding decline for males in most of the countries of northwest Europe, Canada, Australia, and New Zealand. To a lesser extent the same comment applies to the relative decline in death rates among females more than 50 years of age. During the first half of the life span, the mortality rates for males and females in the United States are among the lowest in the world. During the latter half of the life span, the rates for females are near the average of those for similar countries while the rates for males are among the highest of those for similar countries.

Several hypotheses have been advanced to explain this reversal of the relative rank of mortality in the United States during the first half in comparison with that during the second half of the life span but none of these have been adequately tested.

Morbidity

No comprehensive data concerning morbidity for the entire population of the United States

are available. The only extensive morbidity study ever conducted in this country was the National Health Survey of 1935–36, which was a survey of the urban population. Since that time a number of general morbidity surveys of individual communities have been carried out as well as a sample survey for one State but no national study has been undertaken. A few studies of morbidity from specific diseases also have been made.

In 1951 the United States National Committee on Vital and Health Statistics created a subcommittee to study the question of a national morbidity survey and to prepare a plan for such a survey keeping in mind the needs of local areas. The subcommittee recommended that a continuing national morbidity survey be conducted on a scale adequate to provide estimates for 50 regions of the Nation at intervals of 2 years and estimates for the Nation as a whole at 3-month intervals. The survey should be designed to collect information on the incidence and prevalence of diseases, impairments, and injuries, on the duration of any resulting disability, and on the amount and kind of medical care received.

This report (*2*) was published by the Public Health Service in October 1953 and subsequently distributed to a number of interested individuals for comment. Although there has been rather widespread endorsement of the desirability of collecting national morbidity statistics, no funds have been available for initiating this work. There is much yet to be learned concerning variation in the frequency of fatal illness among different groups of the population. The frequency of nonfatal illness, however, greatly exceeds that of fatal illness. Our present knowledge of nonfatal illness in the United States is no further advanced than the knowledge of fatal illness at the beginning of the century.

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(*1*) U. S. Bureau of the Census: Natality and mortality data for counties and cities in the United States tabulated by place of residence, 2-year totals, 1939–40. *In* Vital statistics of the United States. Supp. 1939–40, part III. Washington, D. C., U. S. Government Printing Office, 1943.

(*2*) U. S. National Committee on Vital and Health Statistics, Subcommittee on National Morbidity Survey: Proposal for collection of data on illness and impairments: United States. Washington, D. C., U. S. Public Health Service Pub. No. 333, 1953. Processed.

Poliomyelitis Vaccine Injections

The desired levels of immunity in individuals given poliomyelitis vaccine are best derived from the dose schedule in current use, namely, two 1-cc. injections, the second dose 4 to 6 weeks after the initial dose or as soon thereafter as possible, with a booster dose 7 months or more after the second injection.

This was the unanimous opinion of leading virologists and immunologists representing the medical and health professions and the National Foundation for Infantile Paralysis at a meeting called by the Surgeon General on December 7, 1955, to consider how best to use the supply of poliomyelitis vaccine which will be available in the months ahead and to discuss available data on the methods of using the vaccine and spacing of doses. The discussion centered on the possibility of using one injection of 1 cc. in all susceptible individuals before giving the second and the booster injections.

Although it is evident that the injection of 1 cc. of vaccine produces a marked degree of immunity, there is not enough scientific evidence on the duration of immunity after a single dose to lead to any recommendation for a change in the present dosage, the group decided. The Surgeon General accepted the committee's recommendations.

An environmental sanitation problem for the new atomic age may be created by the discharge of radioactive byproducts of nuclear reactions into surface streams. A first anticipatory step is to measure the effects, however slight, of such contamination.

Effects of Low-Level Radioactivity in the Columbia River

By CROSWELL HENDERSON, M.S., GORDON G. ROBECK, M.S., and RALPH C. PALANGE, M.S.

THE Public Health Service conducted water quality studies on the Columbia River over a period extending from mid-1951 to mid-1953. Presented here is a brief summary of the general aspects of these studies, followed by a more extended account of the radiobiological phases.

Initiation of Studies

In the accumulation of data to be used for pollution control programs throughout the Nation, it was found that information was needed on the Columbia River from at least two standpoints: (*a*) for determining the effects of impoundments, several of which were proposed or under construction, and (*b*) for determining the effects of radioactive wastes on stream quality.

The construction of impoundments encourages the development of industrial sites, especially where additional power becomes available, and of recreational areas. In semiarid regions, such as the Columbia River Basin, the increased availability of water for irrigation brings about the development of agricultural areas. Hence, the waters must serve a variety of interests, and in many cases the interests of one group are in conflict with those of another. In order that all interests may be served effectively, basic water quality inventories are necessary.

From the standpoint of the effects of radioactivity, the interests of health, defense, industry, and agriculture were recognized. As the use of radioactive isotopes continues to expand, the responsibility of public health officials for protecting the general population against harmful effects of ionizing radiation will broaden.

The Atomic Energy Commission and the General Electric Co., the present operating contractor at Richland, Wash., have a real interest in using the Columbia River as a source of industrial water supply and also for disposal of

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mildly radioactive cooling water from the nuclear reactors. They have, therefore, an understandable concern as to the possible effects of proposed multiple impoundments of the river for irrigation and power projects, lest changes in the characteristics of the stream have an unfavorable influence on plant operations. In addition, the joint interests of the States of Washington and Oregon as to the present and future uses of the river were an important consideration.

A continuous program for controlling the discharge of radioactive wastes to the Columbia River has been in effect since the start of plant operations in 1944. This program, carried out by the operating contractors at the Hanford Works, has included not only the control of waste discharges but also the monitoring of the river within and adjacent to the AEC reservation.

Objectives

The principal objectives of the studies, therefore, were to determine (*a*) the water quality characteristics of the stream prior to impoundment and (*b*) the effects of radioactivity on the physical, chemical, and biological characteristics of the stream. The studies also provided data which can be used to establish objectives for comprehensive water pollution control programs. The field work was correlated with the continuous monitoring and research activities of the General Electric Co. at the Hanford Works.

General Procedures

Most of the work was confined to the area between Priest Rapids and Paterson, Wash., a section which includes the Hanford Works and the McNary Reservoir. The latter is an impoundment which was placed in operation in late 1953. Limited studies were also made in Roosevelt Lake, Bonneville Reservoir, and the areas around Portland and Astoria, Oreg., to obtain information on existing impoundments and to determine the persistence of radioactivity to the mouth of the river.

In the Priest Rapids-Paterson section, shown in figure 1, three sampling ranges were located well above the Hanford plant area to serve as control points. Other ranges in this section were located so as to detect the influence of the plant effluents and other variables, such as tributaries, downstream cities, and impoundments. At each range several types of biological samples were collected in the shallow regions, and water samples were collected at 3 to 10 points across the stream. A mileage index system was used to denote a sampling range or cross section; the designation C–362, for example, indicates a sampling point 362 miles above the mouth of the Columbia River.

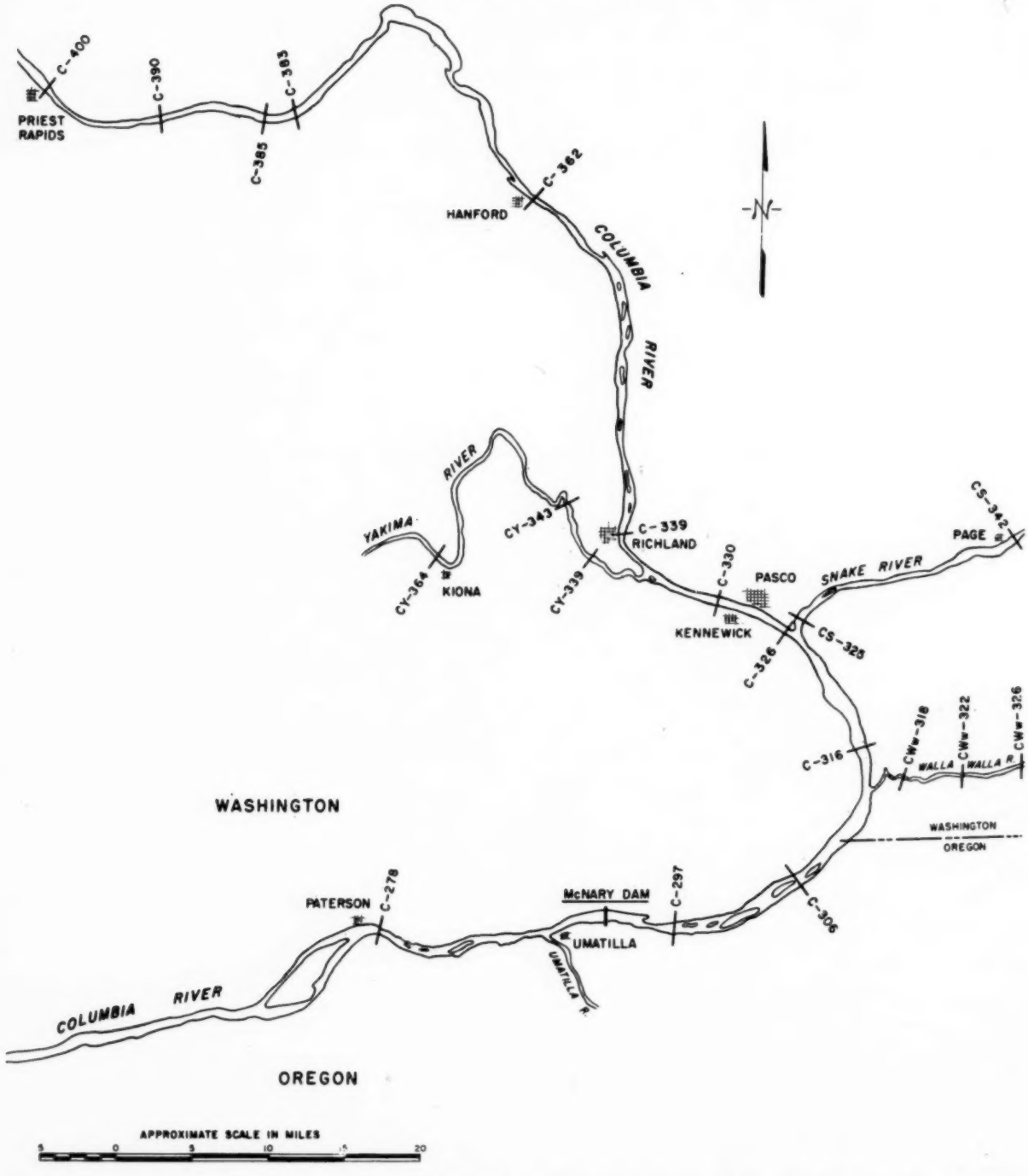
The routine physical and chemical examinations included determinations of turbidity, temperature, dissolved oxygen, ammonia, nitrites, nitrates, phosphates, sulfates, chlorides, pH, and total alkalinity. Mineral analyses were made for the elements considered necessary for plant and animal metabolism, as well as for components which might be toxic. Among these were calcium, magnesium, iron, manganese, zinc, and copper. Bacteriological studies were limited to the determination of coliform MPN.

In the biological studies, quantitative and qualitative samples of plankton, filamentous algae, bottom animals, and fish were collected. The sampling methods were those used in conventional stream surveys. Plankton was quantitatively determined by centrifuging and counting the organisms in a Sedgwick-Rafter counting cell. Bottom animal samples were collected in a square-foot riffle sampler and identified, and the numbers and weights of the various organisms were obtained. Fish were collected in seines and gill nets, and the relative abundance of the various species noted. Observations of spawning activity were made on some species of fish.

Effects on Stream Characteristics

The Hanford plant effluents had no definite measurable effects on any of the physical or chemical characteristics of the Columbia River. Although some of the effluents were thermally hot, the magnitude of the flow in the river was such that there was no general temperature change. On several occasions, slight temperature increases were noted in the area near the

Figure 1. Sampling ranges in the Priest Rapids-Paterson section of the Columbia River, the principal area studied in 1951–53.



effluent outlets. Changes in river flows and the influx of major tributaries did have some effect on the physical and chemical characteristics. However, physical or chemical conditions that would be considered detrimental to aquatic life were not found at any time during the survey.

For many years, the hydrological, physical, and chemical characteristics of the river have followed a definite seasonal pattern. High flows of 300,000 to 400,000 cubic feet per second generally occur between May and July. The most turbid water reaches the Hanford area in

late April or May. During the rest of the year the flow is generally about 50,000 to 60,000 cubic feet per second, and the turbidity is less than 7 p.p.m.

Coliform counts in the Columbia River varied from less than 3.6 to 4,600 MPN per 100 ml. of water. Population centers and tributaries were principally responsible for these variations.

The Hanford plant effluents had little or no effect on numbers and species of river organisms. The variety and abundance of most river organisms were similar above and below the manufacturing areas. Where any differences occurred, they could be attributed to the seasonal variation or the influence of the relatively more turbid, warmer tributaries.

Radiobiological Studies

Although many radioactive wastes and coolants are produced in the manufacture of plutonium at the Hanford plant, the only large effluent to enter the Columbia River directly results from the cooling of the nuclear reactors. The radioactivity is induced by the neutron bombardment of dissolved and suspended materials in the cooling water. The passage of these materials through the atomic pile is held to a minimum by conventional pretreatment of the coolant. The radioisotopes produced in the coolant are principally beta-particle emitters with short half-lives; consequently, retention of the coolant in large open tanks, which provides time for some natural decay, substantially reduces the amount of radioactive material that enters the river.

Water and biological samples, collected weekly or biweekly, were prepared for radiological measurement by reducing the sample to a minimum size for insertion into a Geiger-Müller tube, end-window counter. For most solid samples, reduction was accomplished by digesting the organisms in nitric acid and ashing the digestate in a muffle furnace. The residue was then plated on a 1-inch stainless steel planchet and counted for 5 to 15 minutes. The raw count was corrected for decay, geometry, scatter, and absorption, and the results were reported in terms of microcuries per gram of original tissue.

Average Levels of Radioactivity

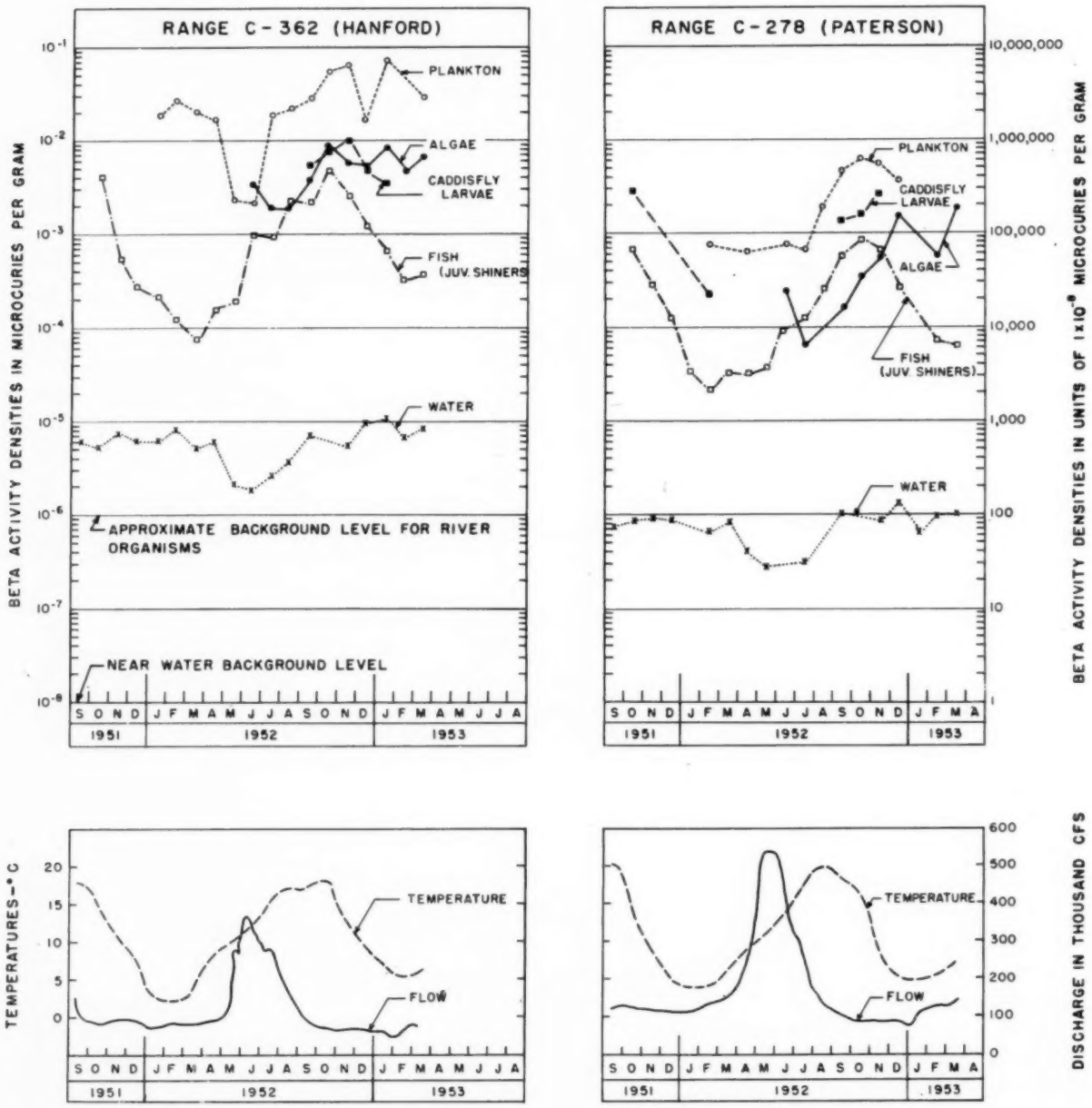
The average gross beta activity density of the water and of the various river organisms (plankton, filamentous algae, caddisfly larvae, and fish) at two of the ranges is given in figure 2. Range C–362, which showed the highest average results, is located just below all nuclear reactors, and range C–278, which showed the lowest average results in the principal study area, is the last range downstream in this section. It is evident from these data that the river organisms concentrate radioactive materials to a considerable degree, up to nearly 10,000 times the total beta activity in the river water. River flows and temperatures at the two ranges are also given in figure 2, for correlation with the radioactivity density.

The accumulation of radioisotopes by aquatic organisms followed a definite pattern. Plankton (mostly phytoplankton) and filamentous algae, which absorb nutrients directly from the water, showed the greatest concentration of radioactive materials. The next greatest concentrations were found in bottom animals, which feed on these organisms; the next, in juvenile fish, which feed principally on the bottom animals. At the end of the chain were the adult game fish, which feed on the juveniles. There were, of course, some deviations from this pattern. Fish that feed directly on plankton and algae reflected higher values in individual samples, whereas crayfish, which possibly feed on dead fish or other animals, reflected lower values.

Levels of radioactivity in plankton and algae were directly dependent upon the radioactivity levels in the water, which were in turn dependent upon river flows and the amount of radioisotopes released into the stream. Values were highest at low water stages, but they were not influenced greatly by changes in water temperature.

Radioactivity levels in most aquatic animals varied with the volume and radioactivity density of the food they consumed. The volume of food consumed depended on their metabolic rate, which in turn depended upon water temperatures. Values for bottom animals were highest at low water stages and high water temperatures. There was a decrease in radioactivity in the organisms with a decrease in water

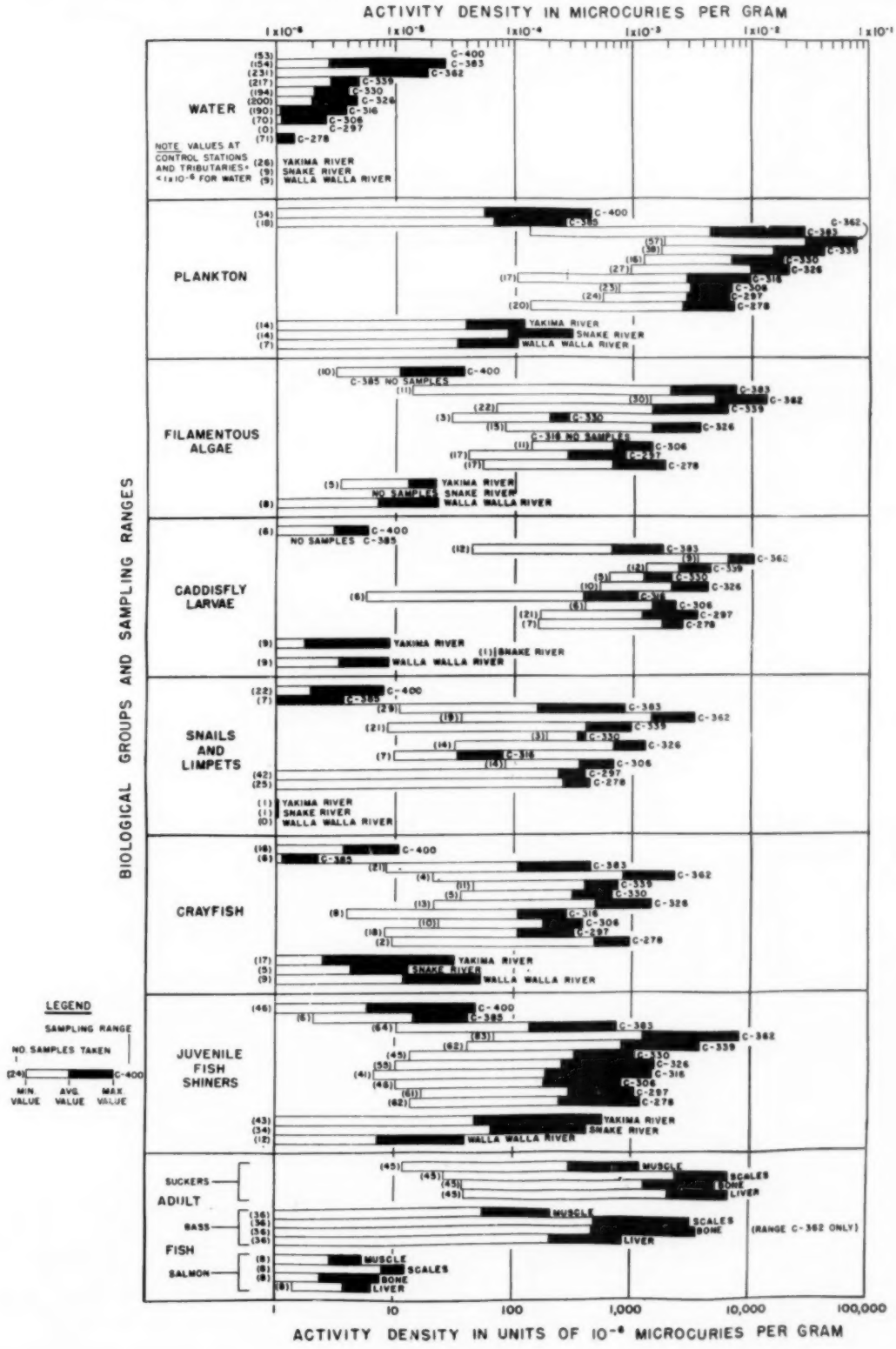
Figure 2. Seasonal variations in beta activity densities in the water and in various organisms of the Columbia River.



temperature, even though the radioactivity of the materials upon which these animals feed remained relatively high.

The decrease in radioactivity levels with a decrease in water temperature was most marked in fish. Some species, such as bass, which are known to stop feeding when water temperatures are low, showed very low radioactivity levels during the winter months in spite of the fact that there was little or no reduction in the radioactivity level of the water. The radioactivity levels in these fish rose rapidly with the resumption of conditions conducive to feeding even though radioactivity levels in the water were lower than previously observed because of increased river flows. In other species, such as suckers and whitefish, which evidently feed to some extent even during periods when the water is cold, the reduction in radioactivity was less pronounced. The radioactivity in adult sal-

Figure 3. Gross beta activity densities in water and in various organisms of the Columbia River.



mon, which migrate to this section of the Columbia River from June to October for spawning but do not feed, remained at very low levels.

Resident species which are feeding during this same period contained relatively large amounts of radioactive materials. Apparently, most aquatic animals concentrate radioisotopes of the type encountered in the Columbia River from the food they eat rather than by absorption through the skin or gills.

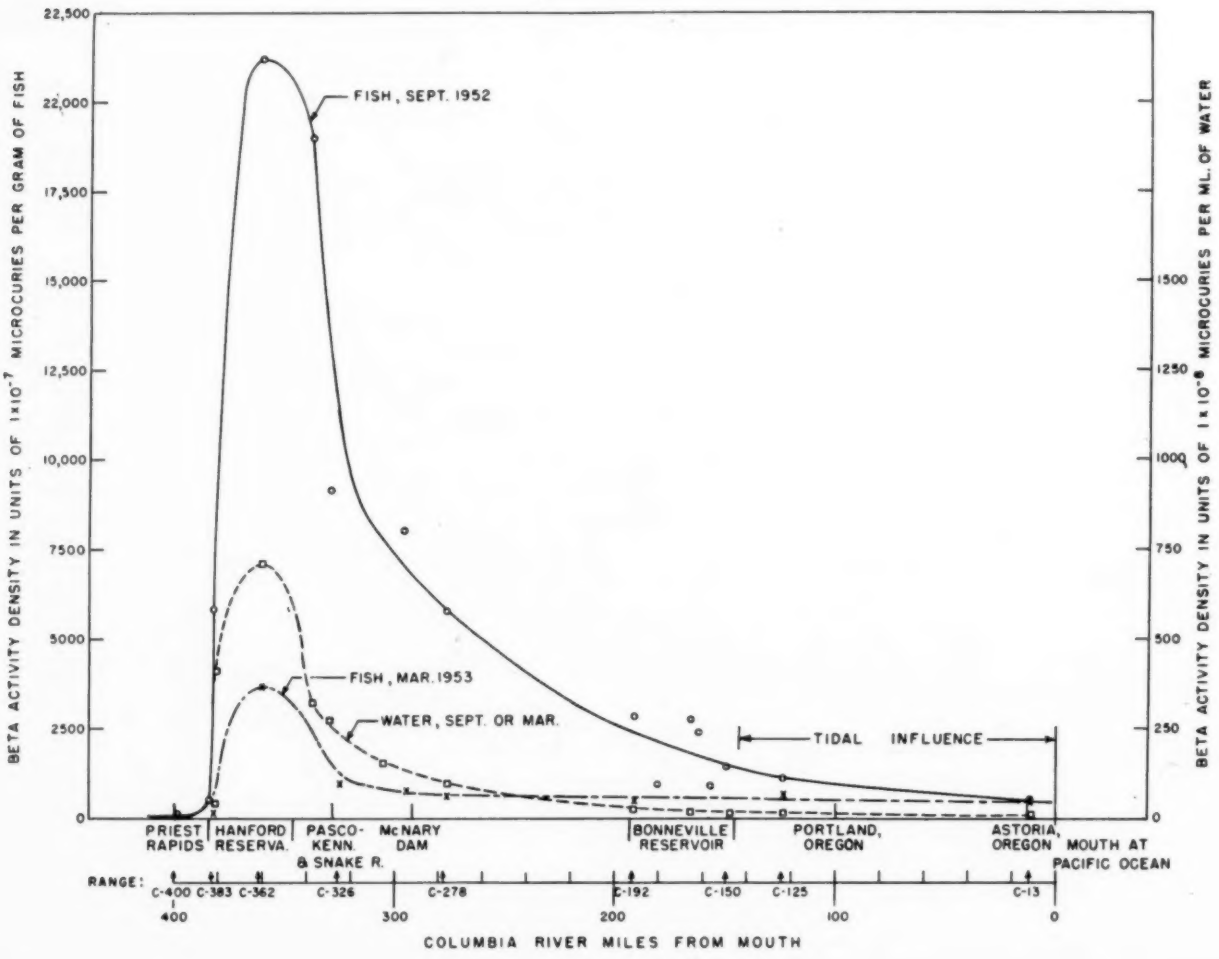
Types of Radioisotopes

The principal radioisotopes in the river water at range C–362 were such short half-life ones as copper–64 (12.8 hours), manganese–56 (2.6 hours), sodium–24 (15.1 hours), arsenic–76 (26.8 hours), and silicon–31 (2.8 hours). At this range, only about 1 to 2 percent of the activity was from the longer half-life phosphorus–32 (14.3 days), but at ranges farther downstream this radioisotope became more predominant percentagewise, since the activity from the short half-life radioisotopes had been reduced at a greater rate by natural decay.

The radioisotopes were selectively absorbed or concentrated differently by the various river organisms. Hatchery experiments with trout and salmon (*1*) have indicated that phosphorus–32 is concentrated in fish principally from food, whereas sodium–24 is absorbed directly from the water. Other radioisotopes may or may not be utilized by the various organisms, but small amounts may be taken into the body in food material.

At range C–362, most of the radioactivity in plankton was due to the short half-life radio-

Figure 4. Variation in average beta activity density in water and fish with location in the Columbia River.



isotopes mentioned previously. The proportion from the somewhat longer half-life phosphorus–32 was relatively small. Some of these short half-life radioisotopes may have been adsorbed on the siliceous diatom shells, which make up a large part of the river plankton. Farther downstream, a larger portion of the activity is caused by phosphorus–32.

The radioactivity in fish and other river animals was primarily from phosphorus–32, even near the areas where nuclear reactors are located. Since the percentage of phosphorus–32 in the water was low, it is evident that this radioisotope was concentrated many thousand times in some river animals. Only a very small part of the radioactivity in any of the river organisms was from radioisotopes with longer half-lives than phosphorus–32.

Variations in Radioactivity Levels

Owing principally to the decay of the relatively short half-life radioisotopes, the gross beta activity density decreased downstream. The activity levels in the river water and in the various river organisms at the different sampling ranges are shown in figure 3. The values decreased rapidly from Hanford (C–362) to Richland (C–339) and somewhat more gradually thereafter, a pattern followed with only slight variations in both the water and the river organisms.

The activity density of adult fish at one sampling range, C–362, is also given in figure 3. The values shown are the highest values for individual parts or organs of each species of fish. The activity density of scales, bones, and internal organs was about 10 times the activity density of the flesh and skin, the edible parts.

The pattern of activity densities in water and fish from Priest Rapids, Wash., to the mouth of the river near Astoria, Oreg., is shown in figure 4. Although some radioactivity is detectable all the way to Astoria, the values are very small in comparison with those found in the Priest Rapids-Paterson section.

The higher radioactivity values found during this survey were from within the Hanford Reservation, but values of similar magnitude have been reported from other areas during a limited period. Values as high as 2.2×10^{-3} μc./gm. have been found in the muscle of whitefish near Priest Rapids (*2*).

Other river organisms had gross beta activity densities considerably higher than adult fish, but these organisms are not utilized to any extent by humans. Thus, their major significance is in transmitting this activity to other organisms in the food chain. Fish, as well as ducks, geese, and other animals, may consume these organisms.

As previously pointed out, there were no observable, immediate biological effects on any of the river organisms from radioactivity levels in the Columbia River found during these studies. The genetic changes that may occur in aquatic organisms over a long period were beyond the scope of these studies. Some work on the question of genetic changes is being carried out by the General Electric Co. (*3*).

Although certain of the radioactivity levels found in the Columbia River organisms appear high when compared to maximum permissible concentrations in the human body, the maximum permissible concentrations for fish and other aquatic organisms have not been definitely established. Some of the work at the University of Washington (*4–6*) has indicated that the amounts of X-radiation of consequence to certain plankton forms and fish are much larger than quantities permissible for man. The effects of such concentrations in fish eaten by man have not been ascertained.

Public Health Aspects

Because fish and other aquatic organisms concentrate radioactive materials many times above the levels found in water, the use of these organisms for human or animal consumption presents a potential public health problem. Fortunately, most of the radioactivity in fish is from phosphorus–32, a relatively short half-life radioisotope. Natural decay helps in reducing the activity before the fish is eaten. Also, a large portion of the activity is in parts of the fish not used for food, such as scales, bones, and internal organs.

Based on a maximum permissible concentration of 200×10^{-6} μc./ml. and an average daily intake of water of 2,200 ml. (*7*), the maximum permissible intake of phosphorus–32 for man is

0.44 μc. a day. The average level of radioactivity for the highest 13-week period in the muscle of Columbia River game fish, such as bass, was 100 x 10^{-6} μc./gm., and in Columbia River suckers it was 500 x 10^{-6} μc./gm. Salmon and other migratory species do not appear to be important from the standpoint of ingestion of radioactive materials by man since very little of these materials are concentrated in the adults of the species.

Although the amount of fish flesh that man might eat daily before reaching the maximum permissible ingestion of radioactive materials can be computed on the basis of the results of these studies, such a figure would not be too realistic. Few, if any, humans would eat the indicated quantity of fish daily over a lifetime. Moreover, the fish are not eaten immediately after being caught, some time being required for cleaning, cooking, and other preparation. Thus, the actual permissible intake would be greater than the figure computed.

Conclusions

The following major conclusions regarding radioactivity in the Columbia River are drawn from the Public Health Service studies of 1951–53:

1. Low-level beta activity has had no adverse effect upon the numbers and species of aquatic organisms in the Columbia River.

2. The radioactivity levels in plankton and attached algae are directly dependent upon levels in the river water.

3. The radioactivity levels in aquatic animals vary with their metabolic rates (which in turn vary with water temperatures) and with the radioactivity levels of the materials upon which they feed.

4. Migratory species in the Columbia River such as salmon, the adults of which do not feed in fresh waters, have low radioactivity levels at the same time that levels in resident species are high.

5. Radioactive materials are concentrated in all parts of the body of the fish. The activity levels, however, are about 10 times higher in scales, bones, and internal organs than in the edible parts, such as muscle and skin.

6. Since aquatic organisms concentrate specific radioisotopes such as phosphorus–32 many thousand times above the levels in water, the use of these organisms for human or animal consumption presents a potential public health problem. However, to date the levels of radioactivity in the flesh of Columbia River fish are not dangerously high.

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New York State used the home interview technique to gather data for determining accident rates for a sample of motor vehicle drivers in Saratoga Springs. From this preliminary study, we learn that it is possible—if the data are sufficient and the population is well defined—to obtain reliable rates on which to base future accident prevention activities.

An Epidemiological Approach to Traffic Accidents

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MOST traffic accidents are apparently due to errors in the decisions of drivers rather than to defects in the motor vehicle or hazards present on the road. It has been estimated from analyses of accident reports that 75 to 90 percent of all traffic accidents can be attributed to human error (*1*). Although accident report data are admittedly not entirely reliable, particularly with regard to the designation of human error as the responsible factor, it remains likely that some large portion of automobile accidents result from miscalculation by the driver.

There is considerable evidence which suggests that several characteristics of the driver are associated with a high risk of involvement in the accident. Persons with high levels of alcohol in the blood have been found to be involved in accidents more frequently than those without such levels of alcohol (*2*, *3*). Individuals who become involved in accidents repeatedly have been characterized as accident prone although the permanence of this characterization is uncertain (*4*). A variety of driver selection studies by commercial and military agencies have tested intelligence, speed and accuracy of perception, learning of coordination, and certain attitudes (*1*). When accident reports from general populations are analyzed according to age, it has been found that young persons between 18 and 25 have a disproportionately high number of accidents (*5*).

To Identify the Hazardous Driver

The many procedures that have been employed have met with varying success in the

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This report was presented in part at the Second Highway Safety Research Correlation Conference on Health, Medical, and Drug Factors in Highway Safety, Washington, D. C., April 1954. The conference was sponsored by the Committee on Highway Safety Research of the National Academy of Sciences-National Research Council.

attempt to identify individuals with a greater likelihood of becoming involved in accidents. The aim common to all such efforts is to identify the hazardous driver in order to exclude him from the driver population, at least until he has been successfully retrained. With few exceptions, however, the evidence supporting these means for detecting hazardous drivers has apparently not been sufficiently convincing to warrant general acceptance as screening procedures by official agencies charged with licensing drivers. This lack of acceptance may be due in part to the nature of the attributes chosen for study or to the particular methodology of the study. Whatever the reason, the result has been that the findings cannot easily be applied to the general population.

The New York State Department of Health thought it worth while to attempt to apply the epidemiological approach to a study of traffic accidents. Consultations with traffic authorities lent encouragement to the plan and also provided essential technical advice. Close sociologic supervision was supplied throughout all stages of the planning and operation of the study. Special attention was given to interviewing techniques and sampling of the population.

The epidemiological method consists essentially, first, of grouping the members of a general population according to well-defined characteristics, such as age, sex, occupation, and, where possible, exposure to the event or disease under study; and, second, of determining the proportion of the groups that experiences the event or becomes ill. This information is useful in order to determine how a disease starts or where it exists in a community, how it spreads, and where control measures should be applied.

The epidemiological approach has proved of value in the control of many diseases—occupational diseases are an example. An epidemiological study, therefore, of certain attributes of the driving population of a community holds promise for ascertaining whether the traffic accident problem is in reality largely one of human behavior.

Figure 1. Proportion of adult population who are drivers, according to age and sex.

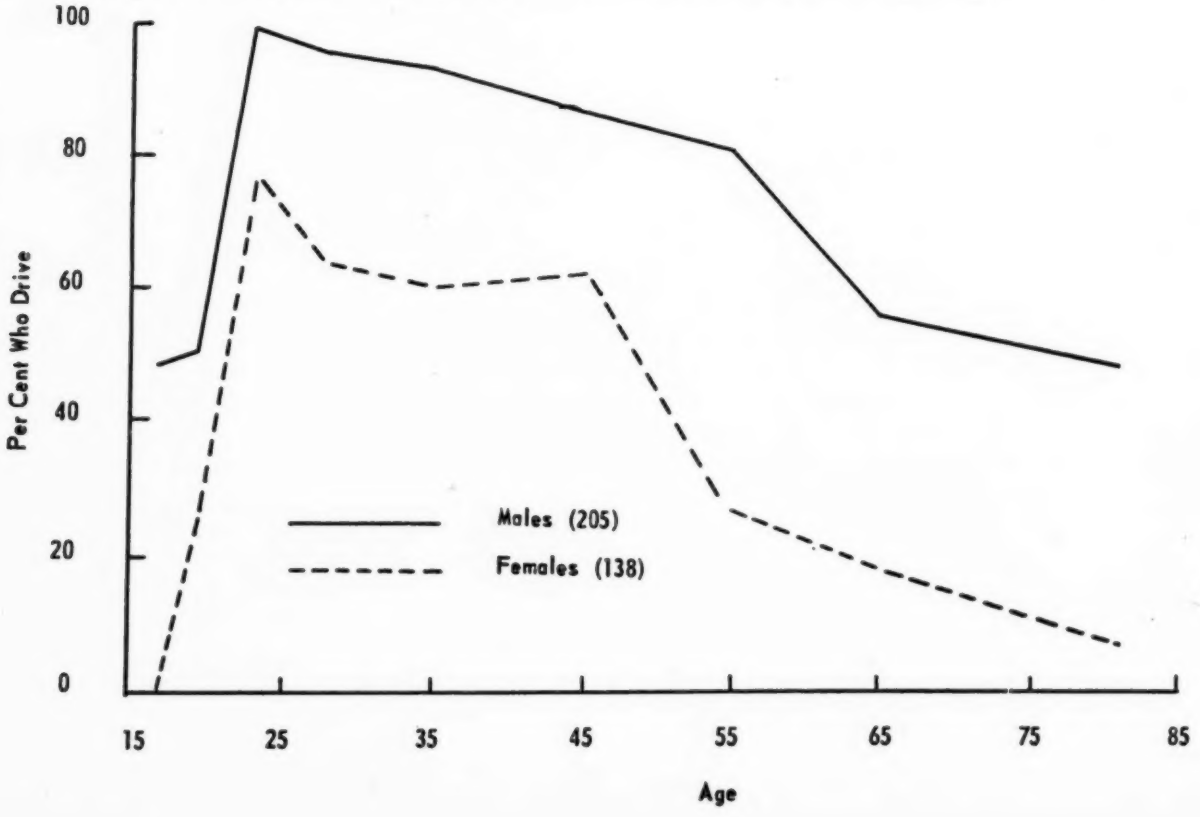
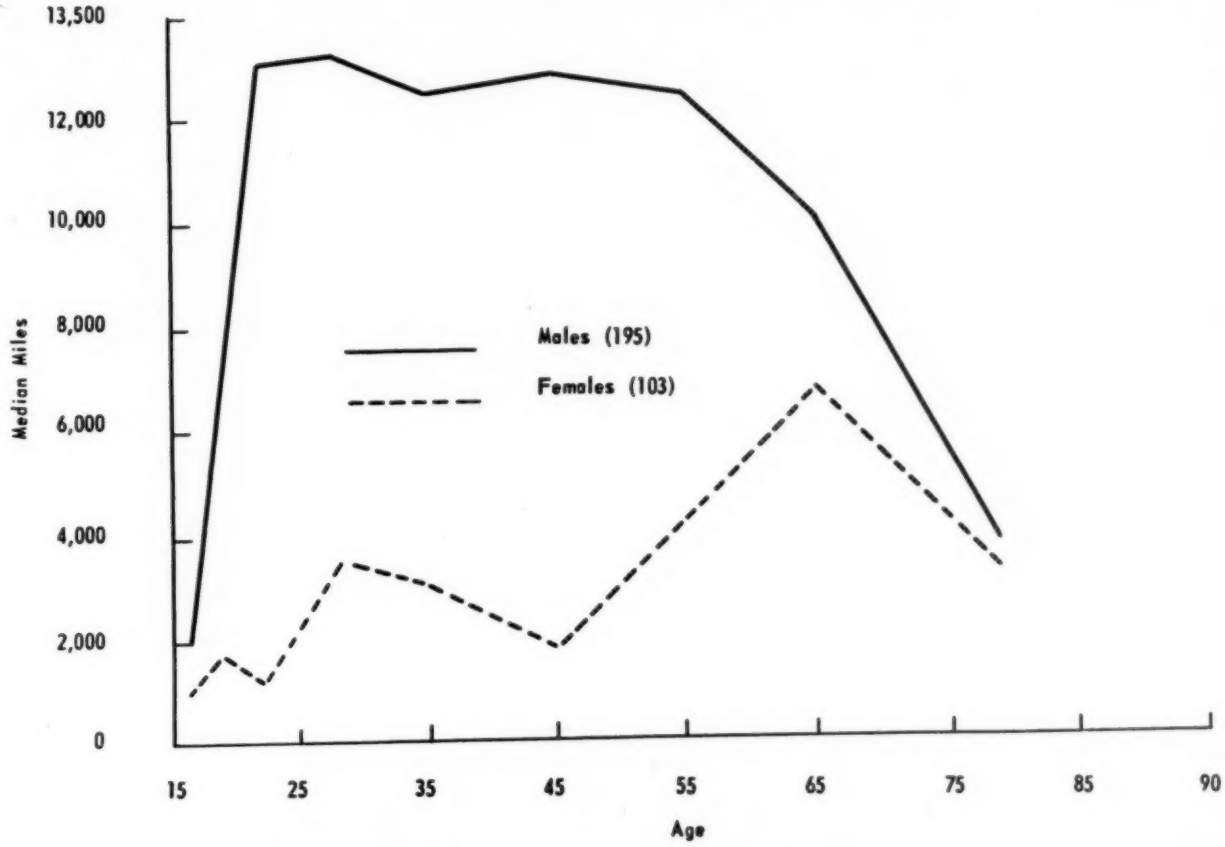


Figure 2. Exposure to traffic accidents in terms of the median miles driven during preceding year, according to age and sex.



This report presents some of the data obtained in the health department's exploratory study in traffic accident epidemiology. In the hope of stimulating critical interest, illustrations of some of the techniques that were employed are presented in the form of graphs or tabulations.

The Sampling Techniques

Our investigation was made during a 3-week period of clear weather in late November and early December 1953 at Saratoga Springs, N. Y. The population studied consisted of a sample carefully selected in the hope that it would be representative of the city and the surrounding natural trading area, a zone of approximately 5 miles. The sampling procedure was one of assigning consecutive numbers to all blocks on a map of the city and to all segments of the rural area, and, then, by reference to a table of random numbers, of choosing a sample of blocks and segments to be studied. Every fourth household of each sample block or segment was assigned for interviewing.

An attempt was made to interview all individuals 15 years and older in the study population. Children under 15 were enumerated only. Interviews were successfully obtained with 563 of the 637 individuals in the study group but not with 74 persons, most of whom were not at home on repeated visits. Seventeen declined to be questioned. The 74 individuals who fell in our theoretical sample, but who were never interviewed, do not form a part of the study population.

The interviewing was handled by 9 biostatisticians, 2 physicians, and 1 cultural anthropologist, all from the health department. Twenty-nine sociology students at Skidmore College assisted. To assure consistency in the use of interview techniques, each interviewer was given several hours of training. Interview questions had been pretested in the city of

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Table 1. Sources of data and severity of accidents occurring to drivers in the study population

Source of data	Number of drivers	Severity			
		Fatal	Personal injury	Property damage	Severity not known
Total	25	1	1	13	10
Interview and motor vehicle bureau file	10	1	1	8	------
Interview alone	9	------	------	------	9
Motor vehicle bureau file alone	6	------	------	5	1

Oneonta with the assistance of sociology students in the Oneonta State Teachers College.

Information was sought on a variety of subjects that can be described briefly as identifying information, exposure to traffic accidents, driving experience in number of years of driving, description of automobile trips on the day before the interview, health status, income, occupation, involvement in a traffic accident occurring earlier in 1953, and some opinions on the driving regulations and traffic problems of Saratoga Springs.

Some of the Findings

Examination was made of the study population by age and sex, according to whether or not the respondent drove a motor vehicle. In all age groups a considerably larger proportion of men than women are drivers, it was found. This finding is illustrated in figure 1, which also shows a steady decline in the proportion of drivers with increase in age. Of the persons interviewed, 264 were men and 299 were women. Seventy-eight percent (205) of the men and 42.5 percent (138) of the women were drivers.

Exposure to traffic accidents was determined in terms of the number of miles that the individual stated he had driven during the preceding months in 1953. The variations in exposure by age and sex are shown in figure 2.

The median number of miles driven per year varies from 1,200 miles (women, 21–24) to more than 13,000 miles (men, 21–29). It can be seen from the figure that the line for women is consistently below that for men, although several points on the curve are based on only a few observations.

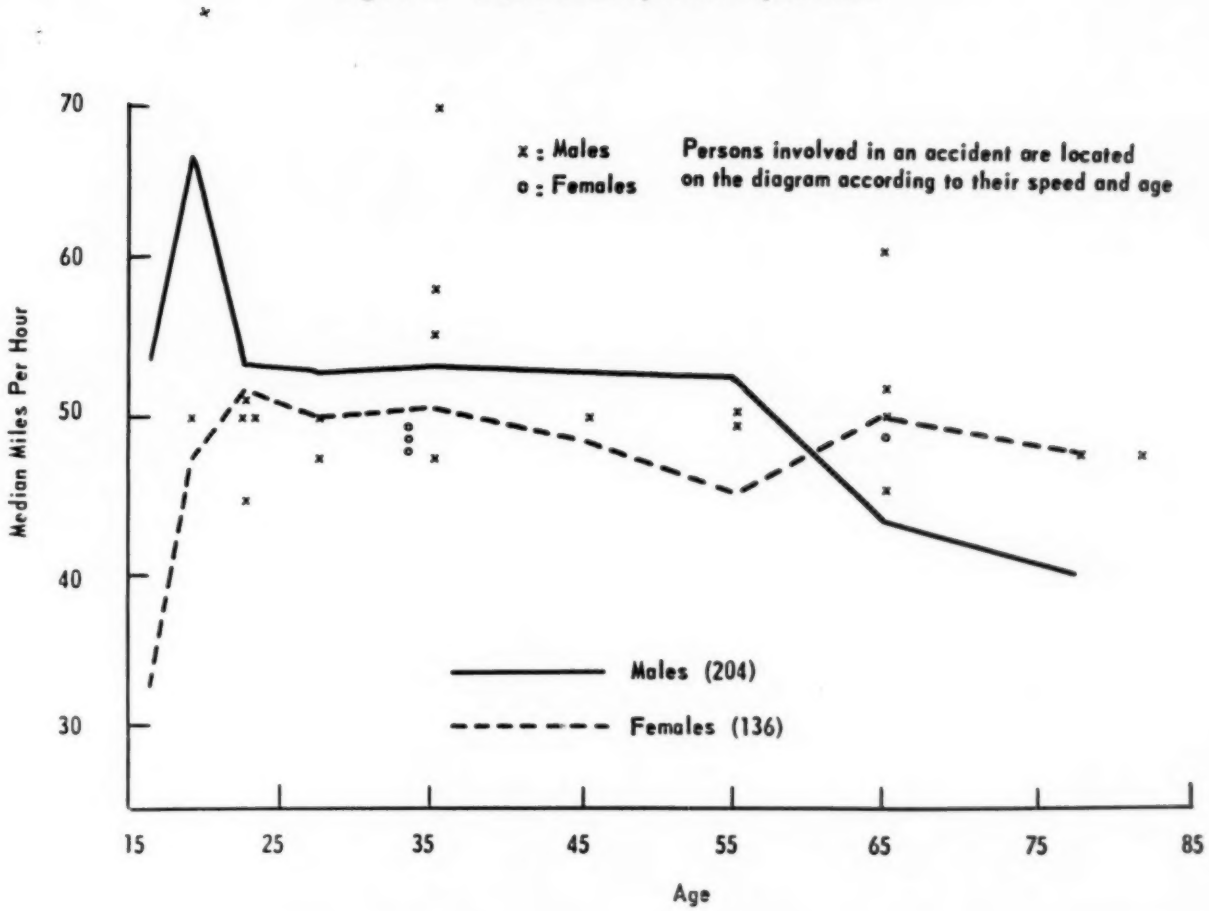
Twenty-five members of the study population had been involved in automobile accidents during the 11-month period between January 1 and

Table 2. Accident rates for the study population according to age, sex, and exposure in terms of median miles driven during 11 months, 1953

Age group	Men					Women				
	Median miles per year (a)	Number of drivers (b)	Total miles (c)	Number of drivers in accident (d)	Accident rate (e)	Median miles per year (f)	Number of drivers (g)	Total miles (h)	Number of drivers in accident (i)	Accident rate (j)
Total	11, 400	208	2, 375, 000	21	8. 8	2, 800	138	380, 000	4	10. 5
15–17	2, 000	8	16, 000	--------	--------	1, 000	1	1, 000	--------	--------
18–20	7, 500	4	30, 000	2	66. 7	1, 700	7	12, 000	--------	--------
21–24	13, 100	17	223, 000	4	17. 9	1, 200	11	13, 000	--------	--------
25–29	13, 300	24	320, 000	2	6. 3	3, 500	25	88, 000	--------	--------
30–39	12, 500	48	600, 000	4	6. 7	3, 100	43	132, 000	3	22. 7
40–49	12, 900	40	514, 000	1	1. 9	1, 900	28	53, 000	--------	--------
50–59	12, 500	29	363, 000	2	5. 5	4, 300	13	55, 000	--------	--------
60–69	10, 000	21	210, 000	4	19. 0	6, 700	8	53, 000	1	18. 7
70–89	3, 500	14	54, 000	1	18. 4	3, 500	2	7, 000	--------	--------
Not stated	--------	3	--------	1	--------	--------	--------	--------	--------	--------

NOTE: Number of miles has been rounded off to nearest hundred. Accident rates were calculated from original figures.

Figure 3. Stated usual speed on open road.



(approximately) December 1, 1953. Data on the number of accident-involved persons and the severity of the accidents are presented in table 1. No distinction was made by our investigators between persons to blame or not to blame for their accidents, nor was the definition of a traffic accident elaborated on in any great detail.

The information about accidents was gathered from two sources: the interview and the New York State Bureau of Motor Vehicles.

In the interview the question was asked, "Have you by any chance been involved in an accident since January 1 of this year? I would like to know about all accidents regardless of whether or not it was your fault or how small it was." The respondent himself was depended on to determine what constituted a motor vehicle accident.

Search of the accident file of the bureau of motor vehicles over the 12-month period January 1 to December 31, 1953, corroborated 10 of the accidents reported by the respondents. However, six reports were found in the bureau file for accidents that were not reported during the interviews. Nine persons stated that they had been in accidents, but reports for these accidents were not found in the bureau file.

A portion of these individuals may have had accidents which occurred outside New York State or accidents which involved no other car. Some also were too minor to report on legal grounds since New York State law requires that reports be filed only for an accident that involves personal injury or property damage over $50. Details were not obtained about the accident during the interview, and, therefore, it is not possible to estimate the severity of the latter group of accidents. We did not expect to obtain as many accidents as we did from the interviews. We anticipated that the severity could be better measured by the official reports.

Accident rates are presented (table 2) according to age, sex, and exposure. In order to derive the rate, the median number of miles driven during the year of exposure (column *a*) was multiplied by the number of drivers in each age group (column *b*). The product (column *c*) represents the total exposure for an age group. The number of accident-involved persons (column *d*) is divided by the total exposure (column *c*) to obtain the accident rate per million miles of exposure (column *e*).

The limited size of the study material, as reflected in the small number of accidents, makes for unstable rates. This instability is especially apparent in the rates shown for women drivers. However, there is a suggestion in the data that men aged 25 to 59 experience lower accident rates than men of other ages.

Table 3. Accident rates for various driver characteristics, according to sex and exposure

Response	Men				Women			
	Number of drivers	Median miles per year	Number of drivers in accident	Accident rate	Number of drivers	Median miles per year	Number of drivers in accident	Accident rate
Alcohol consumption:								
Never drink	48	8, 800	5	11. 9	33	1, 600	----	----
Drink	159	12, 300	16	8. 2	104	3, 200	4	12. 2
Not stated	1	----	----	----	1	----	----	----
Body height-weight evaluation:								
Underweight	12	12, 500	1	6. 7	20	3, 000	1	16. 7
Normal weight	140	10, 900	15	9. 8	92	2, 800	2	7. 8
Overweight	55	12, 700	5	7. 1	24	1, 900	----	----
Not stated	0	----	----	----	2	----	1	----
Wearing glasses while driving:								
Wears glasses	67	11, 800	7	8. 9	49	2, 300	2	17. 7
Does not wear glasses	138	11, 500	14	8. 8	88	3, 000	2	7. 5
Not stated	3	----	----	----	1	----	----	----
Opinion on posted speed limits:								
Too low	29	15, 600	2	4. 4	7	1, 700	1	83. 3
Satisfactory	160	11, 800	19	10. 1	127	2, 800	3	8. 4
Too high	16	4, 300	----	----	1	1, 000	----	----
Not stated	3	----	----	----	3	----	----	----
Stated usual speed on road:								
30–40 m.p.h	17	2, 500	----	----	17	1, 100	----	----
40–50 m.p.h	51	10, 200	4	7. 7	51	3, 300	----	----
50–60 m.p.h	116	13, 500	14	8. 9	58	3, 900	4	17. 6
60–85 m.p.h	19	13, 100	3	12. 0	6	5, 000	----	----
Doesn't drive on open road	4	1, 000	----	----	2	1, 000	----	----
Not stated	1	----	----	----	4	----	----	----
Family income:								
Under $3,000	46	10, 000	4	8. 7	28	5, 000	1	7. 1
$3,000 to $5,000	92	10, 600	12	12. 3	61	2, 000	1	8. 4
$5,000 to $9,000	47	12, 700	4	6. 7	30	3, 700	----	----
$9,000 to $12,000	14	13, 300	----	----	6	1. 700	1	100. 0
$12,000 and over	3	12, 500	1	26. 3	3	3 500	----	----
Not stated	6	25, 000	----	----	10	2, 000	1	50. 0
Where driving is done:								
City	99	10, 900	12	11. 1	75	2, 500	4	21. 3
Country	22	10, 500	1	4. 3	13	2, 000	----	----
Highway	8	17, 500	----	----	4	3, 000	----	----
Mixed	71	12, 200	8	9. 3	41	4, 400	----	----
Own property	3	1, 000	----	----	1	1, 000	----	----
Not stated	5	7, 500	----	----	4	1, 500	----	----

NOTE: Number of miles has been rounded off to nearest hundred. Accident rates were calculated from original figures.

Table 4. Miles driven according to the day of the week

Day of driving	Drivers interviewed	Drove day before interview		Mean miles per person driving
		Number	Percent	
Total	346	235	67.9	33.9
Sunday	66	48	72.7	41.6
Monday	58	37	63.8	17.6
Tuesday	58	44	75.9	42.5
Wednesday	58	40	69.0	26.3
Thursday	32	19	59.4	46.2
Friday	58	37	63.8	23.4
Saturday	16	10	62.5	32.9

The sharp difference in the number of miles driven by men and women is also brought out in table 2. By comparing column *a* with column *f*, we see that a man drives approximately four times as much as a woman. Coupled with this difference is the additional fact that there are more men drivers than women drivers, as shown in figure 1. Thus, for every mile driven by a woman (column *h*), there are 6 miles driven by a man (column *c*).

Some Additional Characteristics

The home interviews produced a variety of additional data. Much of this information would prove useful for further identification of hazardous drivers if the quantity of study material permitted. Several characteristics of drivers are presented (fig. 3 and table 3), to illustrate how a particular age and sex group with a high accident rate could be further analyzed according to such factors as drinking, habitual rural or urban driving, opinion on speed limits, usual speed of driving.

One of these characteristics, the usual speed driven, is diagramed in figure 3. Speeds that respondents said they usually drove on the open highway are plotted against age for both sexes. The line, in the figure, for women lies under the line for men in all age groups below age 65. By designating the 25 accident-involved individuals as *x* and *o* (*x* for men, *o* for women) on the diagram, we can see that accidents are distributed about equally above and below the median speeds. This distribution suggests that high-speed drivers and low-speed drivers experience a similar number of accidents. However, it should be pointed out that correcting the data for driving exposure and for the factor of the reliability of the statements on speed would provide a more accurate interpretation.

Examples of additional characteristics are shown in table 3. These topics presented no insurmountable problems in most of the interviews. Responses were usually given freely, with an effort to be accurate, to such delicate questions as drinking, income, previous driver license suspension—not shown in the table, but license suspension was admitted by 10 persons. The determination of income by interview of a sample in a population has been employed successfully, of course, in numerous sociologic surveys. Several questions were asked about the presence of a chronic disease or a disability—not included in the table either—but the small base population did not yield many individuals so afflicted.

Some examples of the activities which the drivers reported for the day before their interview are examined in tables 4–6. The question as to what trips were made yesterday (table 4), a query frequently used in origin-destination surveys, has been successfully applied to the analysis of traffic flow for the design of traffic arteries (*6*). A group of individuals identified as those who drank before driving was compared with a group who did not drive after drinking (table 5). The time of drinking was compared with the time of driving on that day, about which inquiry had been made earlier in the interview. From the inquiry about medications taken on the day before inter-

Table 5. Alcohol consumption on day before interview

Response	Number of drivers	Percent
Total	346	100.0
Did not drink	271	78.3
Drank	73	21.1
Drove after drinking	27	7.8
Did not drive after drinking	46	13.3
Not stated	2	.6

Table 6. Medications taken on day before interview

Medication	Number of drivers	Persons who drove yesterday		Persons who did not drive yesterday	
		Number	Percent	Number	Percent
Total	346	235	100.0	111	100.0
Antihistamine	5	3	1.3	2	1.8
Aspirin	13	8	3.4	5	4.5
Injected material	1	1	.4	0	0
Insulin	0				
Prescription	10	7	3.0	3	2.7
Sedative	0				
Tonic	4	2	.9	2	1.8
Vitamin	14	10	4.3	4	3.6
Other	4	4	1.7	0	0
Not stated	11	8	3.4	3	2.7
No medication	284	192	81.7	92	82.9

view (table 6), it is of interest that no substantial decrease in driving was observed for the 35 persons who took some type of medicine.

Many additional analyses were attempted of variables of interest in highway safety. Some of these analyses included these characteristics: speed by family income groups, number of trips made and number of passengers carried on day before interview, frequency of driving, time of driving, and stated usual speed on open road according to occupation. More extensive investigation is required to yield reliable information on these factors.

Validation of the Findings

Some characteristics of the study population were compared with those described for the Saratoga Springs area by the 1950 national census in order to see whether the sample studied was truly representative of the community. Close similarity between the sample and the actual population was found in the proportion of men and women, of nonwhites, and of individuals in gross age groupings, household size, occupation, and family income. In the inquiry about occupation, sufficient details were not obtained to permit classification of a professional driver group since the emphasis was placed upon a classification that could be compared with census data.

In an effort to measure validity, the results of the inquiry about age and driver status have been compared with data from another source. A comparison is shown in table 7 of the ages of drivers interviewed in the study and the ages of drivers licensed in upstate New York. The close similarity in the age structure of the two populations serves as evidence for reliability of the sampling and interviewing procedures employed in this study.

The accident rates computed for the data shown in table 3 are intended to illustrate method and cannot be considered stable. The stability of the computed rates was examined by determining the variation that exists in a random subgrouping of the sample. Rates were computed for subgroups according to their household numbers. Variation in rates among the subgroups was found to equal or exceed many of those in the data presented.

Validation of responses on each of the interview topics (table 3) is highly desirable before any inferences are to be drawn and should be done wherever possible in larger samples that may be studied. The validity of responses

Table 7. Composition of driving population in regard to age and sex and in comparison with a 1952 sample of licenses in the New York State Bureau of Motor Vehicles [1]

Age group	Driving population in study						Percentage of drivers licensed by bureau
	Men		Women		Both sexes		
	Number	Percent	Number	Percent	Number	Percent	
Total	205	100.0	138	100.0	343	100.0	100.0
15–17 [2]	8	3.9	1	0.7	9	2.6	1.2
18–20 [2]	4	2.0	7	5.1	11	3.2	4.3
21–24 [2]	17	8.3	11	8.0	28	8.2	7.7
25–29	24	11.7	25	18.1	49	14.3	12.4
30–39	48	23.4	43	31.2	91	26.6	25.5
40–49	40	19.5	28	20.3	68	19.8	20.9
50–59	29	14.1	13	9.4	42	12.2	15.6
60–64	12	5.9	4	2.9	16	4.7	5.5
65 and over	23	11.2	6	4.3	29	8.4	6.9

[1] The sample was taken from licenses of drivers registered with the bureau of motor vehicles in upstate New York.

[2] The age groups 15–24 years include 8 drivers without any license.

should be tested especially for the desire of the respondent to be accurate and his ability to supply accurate estimates of rather complex activities. The estimate of the number of miles driven during the preceding months in 1953 (fig. 2), for example, was difficult to determine for some individuals, particularly for some professional drivers and some housewives. Reliability and accuracy of the responses regarding exposure require further study.

The validity of the estimates of exposure that have been employed in the calculation of accident rates is of special interest. In the inquiry about the driving reported for the day before interview (table 4), approximately two-thirds (67.9 percent) of the drivers had driven an average of 34 miles on the day preceding their questioning. Variations are shown in the proportion of drivers who drove and in the mean number of miles driven according to the day of the week.

The number (33.9) of mean daily miles driven is in close agreement with the estimated annual exposure of 7,750 miles for the members of the study population (this estimate was determined from the data presented graphically in figure 2) and compares well with the national average of 7,800 miles estimated for 1953 (*7*).

The agreement can be demonstrated in this fashion: If 33.9 miles are driven daily by 67.9 percent of the study population, then the entire group of drivers drives an average 23 miles a day. Multiplying 23 by 365 (the number of days in a year) yields approximately 8,400 miles for an estimated year of driving.

Discussion of Values

The foregoing material illustrates methods for gathering and assaying epidemiological data about selected characteristics of automobile drivers that may be of importance in contributing to traffic accidents. The data also serve as a basis for estimating the amount of study material needed to determine reliable accident rates according to relatively well-defined characteristics in the general population. On the basis of these preliminary results, we consider the epidemiological approach applicable to a study of traffic accidents.

The validity of several steps in the application of the method to traffic accidents has been reviewed. To summarize briefly, the sampling procedures employed yielded a population whose attributes were comparable with those described in the 1950 census and also were comparable, with respect to age, to a sample of driver licenses issued by the State bureau of motor vehicles. Inquiry concerning exposure to traffic accidents was found to yield results comparable with data from other sources.

In addition to serving as an illustration of the epidemiological method, some points in this report mark out unequivocal differences in driving experience and exposure in the general population. Almost twice as many men (78 percent) as women (42 percent) drive an automobile. The exposure to traffic accidents in number of miles driven per year for men is approximately 6 times that for women. Marked age-sex differences are seen, both in the proportion of drivers and the amount of annual driving done in a year. Such variations as these offer strong argument for a critical examination of various groups within the driving population as one phase in the search for hazardous drivers.

A measure of the reliability of obtaining accident reports in interviews is apparent from the data shown in table 1. Only some two-thirds of the individuals questioned related the story of accidents that they had previously reported at the time of accident. This measure of agreement represents a lower degree of reliability for interview material on the subject of an accident than that encountered on such topics as exposure and occupation. Improvements in interviewing techniques might increase the yield from this source.

It is not essential, however, to obtain information on an accident from the respondent in the interview so long as official machinery exists for this purpose. Accident reports on file in the bureau of motor vehicles can serve as the sole source for the numerator. Computing accident rates from this secondary but official source should introduce no crucial bias. The study sample, of course, should be of sufficient

size to compensate for the proportion of accidents learned at interview only.

Deserving of mention is the encouraging frankness encountered during the interviews on subject matter ordinarily considered touchy. Information was voluntarily given by most individuals on the matter of drinking, speeding, license suspension, and, in spite of the fact that the interviews were for an automobile accident study, on various physical disabilities and chronic diseases.

A few individuals interviewed did not state their age; a few did not state exposure. Thirteen men and 35 women did not state the number of miles driven. These omissions, which account for the variations in the study population from table to table and chart to chart, result from two factors: The omissions were not discovered soon enough after the interview to be rectified, and the question on exposure was apparently a difficult one for some persons to answer accurately. Interview techniques and questions especially developed to arrive at the estimate of exposure would help respondents supply an accurate figure.

We recognize that information on accident rates related to fairly well defined, stable characteristics may be rewarding for only a portion of accidents. Many accidents may be more closely related to very fleeting human attributes such as temporary emotional tensions. These, of course, present special, complex problems for study and validation.

If we had studies based on populations of suitable size, we could look for answers to such questions as: To what age group among the general population should special efforts be directed with regard to the screening and retraining of automobile drivers who have had accidents? What is the part of the physically impaired person in the accident problem? Of the deaf individual? The intoxicated driver? The habitual speeder? The slow driver?

We have shown that the epidemiological method of evaluating certain characteristics of drivers and other important aspects of the traffic problem can be expected to provide critical results expressed in convincing accident rates. As a result, the New York State Health Department has been sufficiently encouraged to plan a traffic investigation, greater in scope than the Saratoga Springs study, in collaboration with other agencies concerned with the problems of traffic safety.

Two refinements not employed in the Saratoga Springs study will be made in future attempts to define accident-involved individuals. First, accidents that are manifestly the result of the operation of a defective vehicle or of an environmental hazard will be excluded from consideration in those instances where the judgment of the driver is not involved. Second, responsibility for an accident may be fixed for a group of individuals in order to define the accident-susceptible individuals more accurately.

Summary

A method for determining motor vehicle accident rates for groups within a general population has been tested in a preliminary manner by means of home interviews of a sample in a New York State community. It is suggested that, given sufficient data, accident rates can be determined for well-defined population groups which would assist considerably in providing direction and impulse for accident prevention activities.

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The State of the Nation's public health services

Abridged reports from the 54th Conference of the Surgeon General of the Public Health Service and the Chief of the Children's Bureau with the Association of State and Territorial Health Officers, the State Mental Health Authorities, and the State Hospital and Medical Facilities Survey and Construction Authorities, November 6–12, 1955, Washington, D. C.

Opportunities For Nationwide Cooperation

By Marion B. Folsom
Secretary of
Health, Education, and Welfare

This is my first opportunity to meet with a group of State officials whose work is closely connected with the work of the Department of Health, Education, and Welfare. It is an opportunity I deeply welcome. I know the kind of wisdom and experience and integrity you bring to the advancement of public health. And I know the value of meetings of this type, where people may work on common problems, exchange knowledge, and perhaps come up with new ideas for progress.

It is evident that the greatest progress is made in public health when there is closest cooperation between local, State, and Federal officials. Coordination with State health officers is essential if the Federal Government is to do its part effectively. State health officers are close to public health needs and problems. They know at first hand what resources are available. For these reasons, and others, your advice is especially valuable in the early planning stages of any nationwide public health program.

The public health grant program is one of the fields which presents an opportunity for cooperation to provide better health services. Grants-in-aid are extremely useful tools, and like other tools, they need to be improved and modernized from time to time to meet changed conditions and to be more flexible in meeting the needs of each State and Territory.

Just as our programs must keep pace with growth and change, so must our staffs in public health agencies. Yet today, when the potential benefits of public health services are greater than ever before, many State and local health departments are hampered by shortages of trained personnel. Health officers can do much to help solve this problem, as you recognize. There is, for example, an obligation to make more training available to those already on the job. There is also general agreement that the Federal Government has a responsibility in this field. In addition to the programs for traineeships in public health and for increased training of nurses which are proposed, I would welcome suggestions and recommendations from this group as to other ways in which the Department can be helpful.

Now, a word about the allocation plan for poliomyelitis vaccine. It has been, from the beginning, a good example of the type of State and Federal partnership that makes for progress. The executive committee of the State and Territorial Health Officers Association was represented at all the early planning conferences. It played an important role in the development of a workable system of voluntary controls.

Currently, we are depending on State health departments for detailed information and an analysis of the vaccine's performance. This is part of an evaluation of the vaccine's effectiveness which will be made by the Public Health Service's Poliomyelitis Surveillance Unit in Atlanta. Already we have preliminary reports from 11 States covering almost 5 million children. The scientists say these reports indicate the rate of paralytic poliomyelitis was reduced about 75 percent among vaccinated children, as compared with unvaccinated children in the same age groups.

The poliomyelitis vaccination program is an example of widespread application of new medical knowledge. In the 8 months since the effectiveness of the vaccine was first announced and was licensed for general use, the Public Health Service has released enough vaccine to give 2 injections each to more than 12 million children.

Out at the National Institutes of Health, at other Public Health Service laboratories, and through the research grants program, we are searching for answers to the other cripplers and great killers. We still have much to learn about cancer, mental illness, and heart disease. There are possibilities for great benefits to humanity through more research.

It is equally true, however, that we are not yet fully applying the knowledge we already possess. Much more can be done now to prevent disease, to mitigate its disabling effects, and to rehabilitate its victims. Finding ways to do these things, of course, is not easy. There are fiscal problems, personnel problems, problems of public understanding and acceptance, to mention only a few.

But we do share the important essentials—agreement on goals, on principles, and on the ways of working together. We have every reason, therefore, to make steady progress.

In this spirit, I wish you well in the important work you are doing and pledge you all the help that we in the Department are able to give.

The Wide Spectrum Of Our Health Services

By Leonard A. Scheele, M.D.
Surgeon General of the Public Health Service

In his monograph, "The Cost of Sickness and the Price of Health," published by the World Health Organization, Dr. C.-E. A. Winslow writes:

"Progress made in the public-health sciences during the past half century has made it clear

that the heavy burdens of disease can, in large measure, be lifted by the application of scientific knowledge already available; and each year the results of public-health research are broadening the area of possible control."

To most health workers in this country, this statement may seem to be "old hat." We say it again and again—to ourselves, to our colleagues in public health and medicine, to our law-making and appropriating bodies, to our superiors wherever we work, and to the citizens we serve. But we must not allow repetition to dull our senses.

In this country especially, we must keep ourselves keenly sensitive to the "broadening area of possible control." We have gone far in the application of knowledge to the control of diseases which formerly imposed enormous burdens on our people. Some of us here have been in public health work long enough to have witnessed the spectacular decline and virtual disappearance of some of these diseases in our country. Typhoid fever, diphtheria, smallpox, yellow fever, malaria, pellagra, hookworm: the list is long, the accomplishment great.

Success has its perils, however; and one of the most insidious is that our very accomplishments can dazzle us to the point of blindness: blindness to the fact that "each year the results of public health research are broadening the area of possible control." Each year, mind you.

If we are not alert to these rapid advances, if we are not ready and willing to apply the new knowledge as earnestly as we applied the old, we may soon find that we are behind even in our application of "available" knowledge and that public health science again is way ahead of us.

Some health administrators may feel that our major problems today will not yield to the same type of attack that has been suitable for communicable disease control. But we have proof that the public health approach can be equally effective elsewhere. The dramatic reductions in maternal and infant mortality required new specific techniques, but the broad public health approach was the same. Severe nutritional deficiencies, such as pellagra, have yielded to public health attack.

We should recall, also, that our predecessors did not wait for the perfect control techniques against infectious diseases. With enthusiasm and determination, they set out and applied what they had.

Some of the tools they used at first—and used with considerable effect—would no doubt be rejected by public health workers today as too crude, too difficult to apply, too costly, or not effective enough. Subsequently, high precision tools of remarkable specificity were developed for the prevention of some infectious diseases. It may be that this high precision in one field of public health effort has made some of us overly fastidious in our consideration of less specific techniques now being brought forward as possible means of attacking numerous major health problems of the present era.

There is certainly a tendency to be skeptical about or reluctant to the intensive application of new knowledge in some areas—especially if application involves change in our traditional patterns of thought and public health organization.

A few years ago, for example, I stated that improved techniques of case finding and the availability of streptomycin and para-aminosalicylic acid placed health agencies in a position to wage a new offensive campaign against tuberculosis. I said that within a generation, we could reduce tuberculosis to a minor cause of death and disability in the United States. The reaction of some health workers to that statement was skeptical. Fortunately, many others agreed. Since then, the advent of isoniazid has brought my earlier prediction closer to realization.

Our health agencies must not refuse to accept the new life-saving promises of science. The American people do accept those promises. And they will find ways to bring about their fulfillment, even if it means creating new agencies in our States and cities, because their health departments have become enmeshed in their traditional programs and are not ready to move ahead.

The American people have given their health agencies ample evidence of their enthusiasm and acceptance. They are supporting health programs with tax funds and personal donations to a greater extent than ever before. They

are not concerned, however, with the perpetuation of nonproductive enterprises. They are patient—sometimes too patient—but in the long run, they will support only those organizations that are trying to help them meet the problems that most concern them.

Finding Community Needs

We in public health are inclined to take a "mother-knows-best" attitude toward our communities in determining what those critical problems are, and in deciding which services shall be developed. For official health agencies, this attitude is natural to a certain extent, since State and local health departments have long had the legal responsibility to keep track of sickness and death, and they are supposed to know what the problems are and how to solve them. In the voluntary agency, decisions with respect to services are naturally made by leaders who are personally concerned with the specific objectives of the agency. But the official and voluntary health leaders comprise a very small part of the community. Thus, health agencies need to find ways of drawing the public closer in the process of determining issues that affect the whole community.

We would like to think, for example, that "health" has as high priority for the entire adult population as it has for us. Preliminary interviews of a small group in one community showed that the only adults who gave "health" first priority were those who have children, or have been ill recently themselves, or have a relative with long-term illness. Actually, these people comprised only 20 percent of all persons interviewed.

In seeking guides to the public's health needs, a fresh look at our mortality and morbidity data might be enlightening. Dr. Selwyn D. Collins and his co-workers, in the Public Health Service, have recently published a provocative document: Major Causes of Illness of Various Severities and Major Causes of Death in Six Age Periods of Life. The study is based on five Public Health Service surveys of illness, dating back to 1928.

Here are a few of the revelations in this recent review of our Nation's health status.

Serious mental disease, mental deficiency, and neurological disorders account for the highest disability rates in one of those supposedly "healthiest" age groups, our school children, 5 to 14 years of age. The same diseases account for the highest rates in youth (15–24), young adults (25–44), and the middle aged (45–64).

Although diseases of the heart are the first causes of death in each age group from age 25 onward, they do not account for serious disability rates until age 45 years and over.

Many health agencies have apparently lost interest in influenza and pneumonia, the common cold and other minor respiratory ailments. The Conference of State and Territorial Health Officers, for example, has adopted only two recommendations on any of these infections for nearly two decades; and these were with respect to influenza virus studies. Yet in frequency, these diseases outrank all other causes of disabling illness in every age group, from birth to old age. In old age, influenza is exceeded only by diseases of the heart in frequency of disabling cases and bed cases. It is significant too that for children under 15 the first cause of hospital admissions is tonsillectomy, a surgical procedure commonly recommended as a result of respiratory infections.

Dr. Collins writes: "Death has no time dimension; even if the duration of the last illness is tabulated, the data on the death certificate give no idea of the frequency or extent of the many nonfatal illnesses that may have preceded the final illness." I would add that not only are the death certificates mute, but science is also silent about the relation of our lifetime experience with nonfatal illnesses to the occurrence of the final illness.

There is great research interest in these problems today; many stimulating studies are being conducted that may give some answers. Whatever the answers may be, it is clear that the basic principle of public health—prevention—can reduce substantially the assaults of nonfatal illness, if we do but apply this principle wherever science has given us techniques and wherever there is an opportunity.

A Challenging Era

We in public health have demonstrated that massive attacks on specific diseases will pro-

duce results. A massive attack requires a massing of resources: funds, personnel, equipment, materials, and facilities. When the public has been strongly motivated to provide this massing of resources, then prevention, control, and, eventually, eradication can follow. In the chronic illnesses of later life, some prevention and considerable extension of life can be accomplished in a massive attack.

The poliomyelitis vaccination program is the most recent example of what can be done when strong interest and an adequate budget permit a concentrated attack on a preventable disease. A voluntary health agency has had the magnificent courage to channel the public's emotional drive against poliomyelitis into the research and development of the first effective preventive vaccine for paralytic poliomyelitis. The public, thus strongly motivated, has made possible through their representatives in Congress a nationwide program that will not only attack poliomyelitis, but will also strengthen State and local health agencies in basic skills to deal with other viral diseases.

A similar massing of resources in our States and communities could speed the eradication of some diseases which are already declining rapidly and could bring about substantial reductions in deaths and illnesses due to diseases which have shown few signs of retreat.

For example, there is hope for chemoprophylaxis of tuberculosis. The tuberculosis research staff of the Public Health Service has demonstrated that oral isoniazid, administered daily, is effective in preventing tuberculosis in experimental animals. Clinical trials with isoniazid have been initiated for the prevention of tuberculous meningitis and other complications in newly infected children. Twenty-five pediatric centers are cooperating with the Public Health Service and the National Tuberculosis Association in the first large-scale, controlled study using an antimicrobial drug as a prophylactic agent against tuberculosis.

The effectiveness of isoniazid as a general preventive of tuberculosis depends on the outcome of this study and on controlled trials in other and larger population groups. Persons who react positively to tuberculin and persons who exhibit suspicious shadows on X-ray films may be the first to benefit from the preventive and curative properties of isoniazid. The drug can be produced easily in large quantities at a very low cost.

Definitive treatment of tuberculosis can now be administered by the private physician to the patient at home or in the clinic, but with home treatment great care must be taken to prevent the spread of the disease to family members and the community at large. Thus, the supervision and followup of home care patients will become an increasingly important activity for health departments. The need for establishing criteria for the selection of home care patients is also intensified, since in many cases it is the health department's legal responsibility to decide whether the patient must be hospitalized.

Directors of tuberculosis hospitals are eager to make sure that adequate followup is available for patients discharged under isoniazid therapy. In one State, a Veterans Administration hospital reimburses local health departments for periodic X-rays and sputum tests of patients who have been discharged under isoniazid therapy. The health departments provide followup services and thus are able to work with the families of these patients. This arrangement, in which the local health department serves as liaison between patient and hospital, has been approved by the local medical societies.

The Public Health Service is developing a similar program in Alaska. We have contracted with the Territorial health department to conduct an experimental tuberculosis case-finding and home care program as a part of the Alaskan Native Health Service for which we are now responsible.

We can no longer say that the development of home care programs is a future charge on health departments. The time is now. Not only has the entire pattern of tuberculosis control changed, as has syphilis control, the discharge of mental patients under treatment with new drugs is a present problem. The return of mental patients to the community is placing important responsibilities on health departments and mental health authorities not unlike the demands for followup and supervision in the extensive use of isoniazid.

Every State and Territory is now in a position to reduce rheumatic heart disease substantially as a cause of disabling illness and pre-

mature death, and at the same time reduce markedly the onset of rheumatic fever. Progress against these diseases can be added to the long list of public health accomplishments even with future improvements in available techniques.

The recommendations of the Committee on Prevention of Rheumatic Fever and Bacterial Endocarditis of the American Heart Association have the full endorsement of the Public Health Service and the Children's Bureau. We are cooperating actively in the promotion of antibiotic treatment of all cases of streptococcal infection and chemoprophylaxis of recurrent attacks of rheumatic fever.

Public and private agencies have made a good start. They are sponsoring rheumatic fever clinics in more than 600 communities. But if we are to call a halt to rheumatic fever and rheumatic heart disease, we must have thousands more cooperative projects. Through these clinics, practicing physicians, schools, and parents can obtain many necessary supporting services for rheumatic children. Psychiatric advice, educational and vocational counseling, social service, and public health nursing follow-up are made available. Consultative services for the physician in the diagnosis and management of rheumatic fever and rheumatic heart disease also are provided.

A direct attack on the mortality from cancer of the cervix and uterus can now be made. The very promising and challenging results of our demonstration of the cytologic test in large groups of women at Memphis, Tenn., and elsewhere are especially interesting from the point of view of public health administration, in terms of cost, personnel, time, and ease of performance.

Evaluation Studies

These and many other advances in medical and public health science make it essential that health agencies critically examine their present pattern of organization of community services. In marked contrast with public enthusiasm for every advance in the health sciences, public acceptance of the traditional public health structure—the local health unit—seems to have reached a passive state in many communities. People are neither militantly for nor against it. No community institution can be in a more perilous condition than when it commands only passive acceptance.

It is time we found out the basic causes of this indifference. Fortunately, in recent years, there has been a stirring of interest in the evaluation of public health programs and services. The Kellogg Foundation has expressed an interest in the support of research projects in this area. The Public Health Service wants to assist the States and Territories in whatever ways seem feasible. Possible approaches include studies conducted by our own staff; assignment of personnel to assist in State evaluation studies; participation in cooperative projects; and research grants to independent investigators. None of these approaches is exclusive; we should like to know your wishes.

Evaluation studies will require different approaches from those commonly employed in the study of disease behavior or in the rating of community health on a predetermined scale. The intent is to study community patterns and the bases of "health behavior" both in professional health workers and in the public they serve. We shall need the help of sociologists and psychologists as well as that of epidemiologists and statisticians.

Wide Spectrum Problems

Although at the moment we do not know precisely what are and what will be the most effective methods of organizing health services, we certainly know that public health has outgrown the "four-man health unit." New responsibilities have broadened the outlook at the State level to include some of the most stimulating challenges that the health professions have ever encountered.

To borrow a word from this antibiotic era of medicine, we must now be concerned with "wide-spectrum" health problems. The wide spectrum of public health today includes attention to the health and medical components in the broad fields of vocational rehabilitation, welfare, education, employment security, agriculture, housing, water resources, and many others.

Leaders in these fields are constantly turning to public health agencies for advice and cooperation. We, too, must turn to them, offering at the same time our best efforts in the solution of mutual problems. If public health is to go from strength to strength, we must take our opportunities to apply the concepts of prevention in some of these wide-spectrum fields.

Our relationships with our colleagues must be more than routine. If our cooperation is not more than lip service, these agencies will hire their own physicians and health staffs and ignore us. In this challenging period of history, applied science is revolutionizing the material aspects of our universe. If the incredible advances in technology are to be applied with maximum benefit to human life, we must have the widest possible range of bold, creative thinking in the social sciences and in the organizations whose responsibilities are the application of health, educational, and sociological knowledge. We in public health cannot possibly imagine that we possess all the brains, all the wisdom, all the creativity. We need our colleagues in a score of fields, as they need us.

Also, we must redouble our efforts to indoctrinate our State and local medical societies in the values of wide-spectrum health services. We must realize that for nearly a century, general practitioners have had almost no experience in the management of mental and tuberculous patients, for example. Under State laws, this has been the responsibility of the State. Now, advances in medical science are returning many of these patients to the general practitioner, who is also treating an increasing number of aged and chronically ill patients in their homes. But medical care today includes many types of service: nursing, physical therapy, and social work and other related services also must be made available to the home care patient.

Medical societies can be a most constructive influence by encouraging their members to utilize community nursing and related services in the care of these patients. Many urban communities now offer home nursing care, physical rehabilitation, and housekeeper services through the combined programs of official and voluntary health agencies. In smaller communities and rural areas, the opportunity for organizing home nursing services presents a direct challenge to local health departments.

Plans have been developed on the west coast to provide dental care for dependent children of the members of prepayment medical care plans sponsored by labor and management groups. This experiment is of signal importance, since there is a growing demand for prepayment dental care plans covering the general population.

The difficulties inherent in the development of actuarially sound dental health insurance have been widely discussed. The demonstrations conducted by the Public Health Service in cooperation with State and local health departments and dental societies have provided valuable cost data and methodological information on the provision of dental services for children. State health department staffs may find these studies useful should they have opportunities, with State dental societies, to assist in the development of similar programs in their areas.

The health component looms large in such many-faceted social problems as juvenile delinquency, drug addiction, alcoholism, and accident prevention. Society now recognizes that ill health—physical, mental, emotional—is a major factor in producing deviant behavior. Still more encouraging is the growing acceptance, by the groups directly concerned, of preventive medicine and public health as vital parts of the total therapy of these massive problems.

Courts, law enforcement agencies, churches, schools, industries, voluntary organizations, and other groups will turn more and more to their health agencies for help, if help is offered. We should be ready and willing to contribute our best thinking and to participate actively in national, State, and local programs dealing with human behavior that is just as destructive to the individual and the community as is the behavior of an uncontrolled epidemic disease.

Some health departments have begun to explore these areas, in order to identify specific factors and to determine the role they can best play. The team approach to home accidents that has been developed by several State and local health departments, in cooperation with the Public Health Service and the Kellogg

Foundation, offers a valuable method for future study of the health component in highway accidents. The home accident prevention demonstrations pay special attention to the physical and psychological factors, as well as the environmental factors.

Highway engineering, improvements in motor vehicle design and construction, strict law enforcement and education combined have not sufficed to cope with the national problem of motor vehicle accidents. Death rates from this cause have increased steadily for the past 3 years.

We have not learned why the human being behind the wheel, or in the path of a car, behaves as he does. Nor have we learned what to do about his behavior when it is antisocial or self-destructive. We suspect that certain factors may be the basic "causes" of accidents.

We do know that the quality of driving is the chief cause of nearly 40,000 deaths chalked up to "motor vehicle accidents" annually, as well as an estimated 1,300,000 nonfatal injuries. More than 1 million of these nonfatal injuries result in total temporary disability, and 100,000 in permanent impairments. These facts would seem to call for action on the part of local, State, and Federal health agencies as insistently as the spread of infectious diseases.

The Perennial Problem

The shortage of adequately trained public health workers remains critical. This is our perennial problem. Health officials are especially concerned because we are making little headway in reducing the backlog of inadequately trained public health workers. Actually, in some categories, the backlog is increasing. The numbers of sanitation and nursing personnel receiving 4 months or more of advanced training have dropped since 1947 by 68 and 62 percent, respectively.

Public health agencies at all levels must learn to utilize their highly trained personnel more effectively. Auxiliary workers can perform many functions efficiently without having the advanced training now believed necessary for many routine operations. These workers must be used much more extensively. A career in public health must be "sold" to more medical students, nurses, and engineers. Pay scales must be made more realistic and attractive.

Despite the shortage of additional public health recruits with advanced training, health agencies, official and voluntary, should push ahead with the expansion and enrichment of their programs. This is one way to improve recruitment. No matter how many competent men and women are trained, health agencies that offer only routine jobs will always have difficulties in recruiting and especially in holding able young employees.

Our professional schools, including graduate schools of public health, are increasingly concerned with the challenges of wide-spectrum health services. They have the capacity to turn out students who want careers in organizations where they can use the new knowledge and skills they have acquired. Health agencies must make their jobs attractive to graduate students. Many times, a truly satisfying job in a challenging field will counterbalance the deterring effect of low pay.

We cannot expect young men who have received their first training in electronics, nuclear engineering, and industrial processes to be satisfied with routine sanitation operations. No more can we expect young physicians who have been indoctrinated with the new concepts of chronic disease control, medical rehabilitation, hospital administration, and mental hygiene to be satisfied with assignments only to routine immunization clinics and repetitive case finding in traditional control programs.

Further Observations

Even though there are far more jobs to be done than there are people to do them, or funds to pay for the doing, we must take heart and go forward. It is not possible for any one organization to do the whole job. We have not yet begun to utilize all the resources that our communities may have in reserve. The health agencies can often accomplish more by being the active sparkplug and generator than by attempting to be the entire engine.

We have learned this lesson after a few years of desultory effort to control a few chronic diseases. Now we are seeking new approaches to

this perplexing problem: cooperative planning and provision of services for the care of long-term patients—regardless of the causes of disability.

A new concept is emerging of the kinds of services and facilities that will be required for comprehensive care of the chronically ill, the disabled, and the aged. This concept recognizes the need for a wide variety of services and facilities, but the emphasis is on prevention and rehabilitation. The patient is viewed as a person in his home in his own community where he will receive the greatest part of his care under the supervision of his personal physician. The community remains the central factor in any plan for his care.

Application of this concept presents our State and local health departments with many opportunities to work with practicing physicians for better health of the individual, the community, and therefore, of the entire Nation.

I have mentioned some areas for work, and I am sure that you can name many more. The question before you now is "How many health departments will seize the opportunities—and when?"

Current Trends In Child Health

By Martha M. Eliot, M.D., Sc.D.
Chief of the
Children's Bureau

For those of us in the Children's Bureau, this meeting is a high point in the year's activities. The very process of reviewing the highlights of the past year that are significant for mothers and children may suggest new activities or new ways of strengthening older programs.

The increase to $15 million in the appropriation for the crippled children's program is evidence of the widespread interest in the handicapped child and of skillful administration of the crippled children's programs by the States. In 32 States they have become significant community medical care programs in which the quality of service is recognized as exemplary.

To assist in the continued development of these programs, regional conferences of State crippled children's agencies have been held recently. Some of the Nation's outstanding specialists in orthopedics, epilepsy, psychiatry, congenital heart disease and rheumatic fever, hearing impairment, mental retardation, and cerebral palsy took part.

The increasing concern about long-term illness in childhood to some extent reflects changes that have been taking place in pediatric practice. With the specific agents available for treating acute infectious diseases, fewer children with such illnesses now need hospital care. Many can be treated at home or in outpatient clinics.

Consequently, chronic diseases and crippling conditions now make up a greater proportion of illnesses in childhood and account for a growing proportion of pediatric inpatients in hospitals. This increasing trend is beginning to make a reorientation necessary in the teaching of medical students and nurses and in the postgraduate work of physicians.

Helping Crippled Children

From our experience with the administration of the State crippled children's programs we have learned much about the importance of a multiprofessional approach to the patient—an approach which considers his individual personality and stage of growth, his handicap or illness, his family and the community in which he lives, and what kind of an adult he may become. Together we have learned much about the principles and policies underlying the administration of a medical care program.

The crippled children's program has been fortunate in having the devoted support of members of the medical and related health and social work professions. Indeed, these programs could not have continued if we had not learned how to work with medical professional organizations and with the many public and voluntary organizations whose cooperation and participation are so important.

Children suffering from congenital heart dis-

ease are now being treated with a success that was only dreamed of a decade ago. Today's operative techniques not only save the lives of many of these babies but give them a chance to grow up normally.

At the Second World Congress of Cardiology (1954), two-thirds of 244 children helped by the Blalock-Taussig operation were reported to be maintaining their gains 5 to 8 years later. The improved operative procedure makes it possible to repair defects inside the hearts of babies less than a year old and of older children as well.

Among the newest of the special projects under the crippled children's program are those in California and Michigan for the development and use of artificial hands. The grant to Michigan is enabling the Crippled Children's Commission to serve as a regional resource, extending help to many children in the midwest. This program, like the one for children with congenital heart disease, is another example of how the benefits of research, especially those of such highly technical and costly types as these, can be made available to children in rural areas through organized programs administered by public agencies.

School Health Services

Two significant conferences on school health were held in October 1955: the Fifth Annual National Conference on Physicians and Schools and the National Conference on Priorities for Nursing Services for School Age Children. The health of school age children will be featured at the November 1955 meeting of the American Public Health Association in Kansas City.

The Children's Bureau works closely with the Public Health Service on many undertakings aimed at improving the health of mothers and children. The Bureau, the Public Health Service, and the Office of Education, through the Departmental Committee on School Health, review ways in which we can be of assistance to State health officers.

This heightened interest in school health services, as in education itself, is largely a result of pressures brought about by the increase in the child population.

The United States has 37,277,000 children of school age, children between 5 and 17 years of age. All need basic health care, including comprehensive medical and dental examinations at periodic intervals with special consultation and diagnostic service as required; immunizations against contagious diseases; continuous observation by parents, teachers, nurses, and others to detect early deviations from the child's usual physical, nutritional, or emotional well-being; frequent tests of hearing and vision; and the correction and treatment of physical and mental defects and conditions, particularly those likely to interfere with educational progress and normal growth and development.

Case finding of physical handicaps has value only to the degree that parents obtain the necessary medical attention for their children. That many children do not receive corrective follow-up before adulthood is attested by the rejection for medical reasons of 46 percent of selective service registrants between 1948 and 1955.

Studies have repeatedly brought out that children do not receive the treatment recommended by school health services because of the parents' inability to pay for care, the lack of appreciation on the part of parents and children of the importance of taking the necessary steps to obtain care, and the inadequacy of resources to provide diagnosis and treatment, particularly of a specialized nature, in rural areas and in the new suburbs and communities that spring up near rapidly expanding industries.

School Lunch Program

The National School Lunch Program continues to improve the health of vast numbers of children. We are well aware that the nutritionists in the State health departments, the maternal and child health divisions, have made real contributions to this program.

The 1955–56 program, enriched by grants and surplus foods from the United States Department of Agriculture, is expected to exceed $600 million in money value, half of which will come from the children who consume the low-cost meals and milk and close to a third, from the Federal Government.

Last year, the lunch program reached a peak of 11 million youngsters. A special milk program, launched for the first time, resulted in an increased consumption of 451 million half-pints of milk by well over 8 million children.

The Incidence of Prematurity

The decline in infant mortality has caused many people to look closer at the problem of perinatal mortality, that is, fetal and neonatal losses. In 1953, fatalities to infants before, during, and just after birth numbered about 162,000. These deaths were about 10 percent of the total mortality in the United States at all ages and from all causes. Much of this perinatal loss is associated with premature termination of pregnancy. About 57 percent of all neonatal deaths are in premature infants. When the small premature infant survives, chances of neurological disorders are greater than for the full-term baby whose mother's pregnancy has been free of complications.

To assist us in our efforts to reduce the incidence of prematurity, the Children's Bureau is working with the National Office of Vital Statistics, State health departments, and other groups to get more trustworthy statistics about the incidence of prematurity and the bearing of socioeconomic, familial, and clinical factors upon its occurrence.

To this end, we are working toward more complete and accurate reporting of fetal loss and for wider agreements among clinicians, public health statisticians, and directors of maternal and child health programs as to how we shall study significant events in the mother's pregnancy and in the prenatal period. We are also consulting with a number of States on their studies of prenatal mortality and prematurity.

Blindness in premature infants may soon be rare now that excessive oxygen administration has definitely been implicated in its causation. State health departments have publicized to the medical profession the conclusions drawn from the study of retrolental fibroplasia in 18 hospitals. Although the incidence of this pathological condition has dropped in numerous hospitals, more work is needed to assure a higher degree of accuracy in the concentration of oxygen being supplied to infants in incubators. The limitation in the use of oxygen when necessary for very small infants does not seem to have resulted in a higher mortality among premature infants as was feared.

Poison Control Centers

With accidents the leading cause of death among children, poison control centers are a new development in many cities. A committee of the Illinois Academy of Pediatrics cooperating with the Chicago Board of Health established the first center in 1954. There are centers in Boston, Cincinnati, Dallas, Durham, N. C., Indianapolis, Louisville, New York City, Phoenix, Springfield, Ill., and Washington, D. C. Poison control centers provide information on toxic household chemicals, advise hospitals on appropriate treatment, and educate parents on prevention and first aid.

Mental Retardation

Last year I reported that parents of mentally retarded children were doing much to bring to public attention the problems they have in bringing up their handicapped children. The Children's Bureau is currently making grants to three States for special projects in this area. Other States are developing plans for diagnostic evaluation centers and for day-care centers, nursery school classes, social services, and other community resources. The Congress has expressed considerable interest in this problem and has encouraged the Department of Health, Education, and Welfare to extend its activities in this field.

Mental retardation was the subject of a discussion this year by the Federal Interdepartmental Committee on Children and Youth. Reports were presented on the current activities of the National Institute of Mental Health of the Public Health Service, Office of Vocational Rehabilitation, Bureau of Employment Security, Office of Education, and the Children's Bureau. The committee is planning a 2-day seminar on mental retardation for the spring of 1956.

Migratory Workers

Following the East Coast Migrant Conference last year all of the 10 States in the east coast migrant stream have been active in different ways.

Pennsylvania is developing day-care centers in Potter County.

Florida is completing the first stage of a special study of the health problems of migrant families as recognized by the migrants themselves. The study will provide basic information which should be useful in making realistic plans to extend help to children and their families.

Colorado and Idaho have special health projects for caring for migrant families.

Some of the State health departments are using maternal and child health and crippled children's funds or State funds to increase health services in areas to which migrants come. States have been ingenious in finding ways of overcoming the staffing problem at peak seasons, for example, by employing medical students in the summer, high school science teachers as extra sanitary inspectors, and by assigning school nurses to assist the regular public health nurses in the summer term.

The President's Committee on Migratory Labor has completed its first year of coordinated Federal activity. In October 1955 this Cabinet-level committee laid out a program for the coming months. Among its activities it will seek ways of easing residency requirements for eligibility for service—requirements which disqualify migrants in many programs, especially welfare and medical care. Another activity will be studies of housing needs.

Protecting Adoptions

Problems of unmarried mothers and the adoption of children have long been a major interest of the Bureau. The most publicized problem is that of the number of children being adopted without minimum protections, the babies who are sold to adoptive couples. The idea of selling babies is intolerable, but the practice continues.

The Children's Bureau has sought the knowledge of people who have had contact with one or more of the parties to a black market adoption. The line between a black market placement for money and many others where money does not change hands is very fine indeed. The hazards can be just as great for the child, his natural, and his adoptive parents.

We have asked some preliminary questions regarding the availability and adequacy of medical care for unmarried mothers, about legal requirements and restrictions on community services to girls who have left their home to lose themselves in a big city, about the availability and adequacy of social services, about certain policies and practices of adoption agencies that seem to facilitate or hinder the meeting of the needs of the unmarried mother and her child, about agency practices regarding the couples who want to adopt children.

In June 1955 the Bureau held a conference with 31 national agencies and organizations to discuss the need for protecting children in adoptions. The Academy of Pediatrics, the Academy of General Practice, the American Hospital Association, the American Public Health Association, the Academy of Obstetrics and Gynecology, the Association of State and Territorial Health Officers, and legal and social agencies were represented.

The conference brought out the need to concentrate on providing medical and social services acceptable to the unmarried mother, clarifying the responsibilities of the professions concerned in adoptions, and securing legislation which will assure legal safeguards to protect the child, his natural and adoptive parents.

The Bureau employs a special consultant on unprotected adoptions and services to unmarried mothers.

A study of the problems involved in providing medical care to these mothers is being contemplated.

Juvenile Delinquency

In May 1955 the Children's Bureau called a conference on health services and juvenile delinquency in which State health department personnel participated. It was one of the few occasions when a conference on delinquency has focused on the relationship of delinquency and child health and public health. The discussion centered on the parent-child relationship and

the importance of understanding the factors influencing personality development.

The conference discussed school health services as a resource for the prevention of delinquency and emphasized these points:

- Early identification of high risk children.
- Spotting symptoms of aggressive or withdrawn behavior (stealing, truancy, not working to capacity, reading retardation).
- The need for child guidance services in the health programs in schools.
- The use of ancillary personnel without formal training for counseling.
- The need for more emphasis on the emotional component of growth and development in the training of all professional persons.
- Ways in which personnel can help prevent situations of crisis proportions and provide first aid when a crisis arises.
- Responsibility of health personnel for taking action.

A symposium on juvenile delinquency was a prominent feature of the recent annual meeting of the American Academy of Pediatrics.

The symposium was directed particularly to the health aspects of the subject, to the role of the practicing pediatrician in prevention and treatment, to the importance early relationships in the family have for personality development. Frequently, the social and moral environment makes it difficult for children to establish satisfactory relationships between themselves and the world in which they live.

In closing, I would like to return to the matter of the responsibility of the State health departments for maternal and child health and crippled children's services. These two programs, when in one State agency or when closely coordinated in separate State agencies, contain all the elements necessary to provide adequate health care for children. It seems to me that possibly these services and facilities could be used more effectively to the great advantage of many children known to other State agencies, particularly agencies providing for welfare and education.

Earlier, when I referred to the current interest in school health services, I did not speak specifically of the children for whom the child welfare programs are responsible—the children in institutions, in foster family care, or in their own homes—or of the large group of dependent children who are deprived of parental support and in receipt of public assistance, or of children dependent on local relief. No doubt various lines of cooperation exist in many States and communities. I bring this question to your attention now so that you and your staffs may perhaps renew your consideration of whether the best use is being made of your resources.

Community Air Pollution, A Developing Health Problem

By Justin M. Andrews, Sc.D., LL.D.
Associate Chief for Program,
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Until recent years community air pollution in the United States has been regarded as the cause of a series of local problems susceptible to local solution. However, the expansion of population and industry in the past few decades has combined hundreds of air pollution sources into composite air pollution areas with which individual local authorities cannot cope on the basis of present knowledge. These areas have developed air pollution problems of enormous complexity involving more than one State in some cases and, in many instances, a large number of uncoordinated legal jurisdictions.

The simultaneous outpouring of many gases, fumes, and particulates into the Nation's ambient atmosphere, and the subsequent interactions and combinations of these pollutants in the air have damaged vegetation, livestock, physical structures and other materials, and have decreased property values. Among exposed populations, it has caused untimely deaths, unncessary suffering, acute and prolonged irritation.

If permitted to continue without restriction, community air pollution may be expected to

cause increasing hazards wherever it occurs. Such harrowing episodes as those which took place in Glasgow in 1909 and 1925, the Meuse Valley of Belgium in 1930, London in 1948 and again in 1952, Donora, Pa., in 1948, and in Poza Rica, Mexico, in 1950, signify what may occur in many other places, unless means can be found to contend effectively and economically with aerial effluents which threaten life and property.

Ad Hoc Committee

Public and official attention was again directed to this menace during recent years by the disturbing occurrences of community air pollution, or "smog" as it is locally known, in the Los Angeles area. The Congress was concerned not only about the California situation but about the evidence of increasing atmospheric pollution in other States.

At the informal suggestion of the White House, the Secretary of the Department of Health, Education, and Welfare invited the heads of certain other Federal agencies and departments—Atomic Energy Commission, Agriculture, Commerce, Defense, Interior, and the National Science Foundation—to nominate policy level representatives to an Ad Hoc Interdepartmental Committee on Community Air Pollution.

The first meeting of this group convened under the chairmanship of the Surgeon General of the Public Health Service on November 16, 1954. Several other conferences were held thereafter, some of them with technical deputies from the various agencies.

For its own purposes, the committee developed the following definition of community pollution:

"Community air pollution is the presence in the ambient atmosphere of substances put there by the activities of man in concentrations sufficient to interfere directly or indirectly with his comfort, safety, or health, or with the full use and enjoyment of his property. In general, it does not refer to the atmospheric pollution incident to employment in areas where workers are employed, nor it is concerned with airborne agents of communicable disease, nor with overt or covert acts of war."

The committee reviewed the statutory bases for the interest of the participating agencies and appraised existing knowledge pertaining to community air pollution. Members were unanimous in the conviction that existing gaps in essential information could be filled only by coordinated research specifically directed to the problem by competent medical, scientist, and engineer investigators. They expressed the belief that the determination of basic criteria of air cleanliness in the community atmosphere is a public responsibility and that such criteria must be based on definitive, scientific data and considered in relation to all the pollutants present.

The committee recognized that the funding of comprehensive studies as a basis for these determinations and for the establishment of facts concerning nonindustrial community air pollution was beyond the usual resources of single States. In view of the national interest, therefore, the committee considered that it was a proper responsibility of the Federal Government to provide leadership and supplementary means in solving these and related air pollution problems, making the most effective utilization of existing competencies and facilities, and inviting and encouraging as much research as can be performed or supported by States, industry, and other agencies.

As to the role of Federal and State-local governmental agencies in controlling and regulating community air pollution, the committee recommended the designation of the Department of Health, Education, and Welfare to sponsor and support pertinent legislation and to direct a Federal program in this field; and the establishment of an interdepartmental committee on community air pollution on a continuing basis. The committee also suggested the scientific areas in which funds should be assigned if appropriated by Congress. This information is contained in a report released on April 8, 1955.

In the meantime, several bills, amendments, and joint resolutions pertaining to air pollution had been proposed in Congress. In reporting on them to the congressional committees concerned, the Secretary of Health, Education, and Welfare made suggestions consistent with

the general philosophy of the ad hoc committee, as indicated above.

Air Pollution Control Act

On July 14, 1955, the President approved Public Law 159, following its passage by the Congress. The Air Pollution Control Act authorizes the Surgeon General of the Public Health Service, under the supervision and direction of the Secretary of Health, Education, and Welfare, to conduct a program of research and technical assistance relating to air pollution, with an appropriation not to exceed $5 million annually for each of the fiscal years 1956 through 1960.

The act declares "the policy of Congress to preserve and protect the primary responsibilities and rights of States and local governments in controlling air pollution, to support and aid technical research, to devise and develop methods of abating such pollution, and to provide Federal technical services and financial aid to State and local government air pollution control agencies and other public or private agencies and institutions in the formulation and execution of their air pollution abatement research programs."

This is a very broad act which recognizes that air pollution may endanger health and welfare, injure agricultural crops and livestock, damage property, and create hazards to air and ground transportation. Thus, it is not limited to health in its implementing provisions.

Specifically, the Surgeon General is authorized or enjoined, with respect to air pollution and its control, to—

Cooperate with governmental (Federal, State, and local) and private agencies, institutions, industry, and other organizations in preparing research programs and in undertaking joint studies with any such groups.

Encourage cooperative activities by State and local governmental agencies.

Collect and disseminate information.

Conduct research in the Public Health Service and support and aid the conduct of research by State and local air pollution control agencies and other agencies and institutions, and to publish the results thereof.

Conduct investigations and make surveys concerning specific problems when requested by any State or local air pollution control agency, and publish reports of findings.

Make grants or let contracts for research, training, and demonstration projects to State and local government air pollution control agencies, and other public and private agencies and institutions, and to individuals.

A supplemental appropriation to implement Public Law 159 was passed also at the last session of Congress. This appropriation plus funds from the Public Health Service regular appropriation makes a total of $1,785,000 available for community air pollution research and technical assistance during fiscal 1956.

Program Under Way

The technical assistance program has been initiated. Personnel have been assigned to assist the Los Angeles Air Pollution Control District through the California State Department of Public Health. Similar assistance has also been extended to Louisville, Ky.

Requests for extensive investigations have been received from 28 State governments and local communities as of November 1, 1955. These requests do not include the numerous calls for consulting services received from many other different parts of the country.

Short courses in the technical aspects of air pollution control are scheduled to be held at the Robert A. Taft Sanitary Engineering Center of the Public Health Service in Cincinnati. No funds for training or demonstration grants are available during fiscal 1956.

The research activities planned for this fiscal year will be carried on (*a*) directly by the Public Health Service in Cincinnati both at the Sanitary Engineering Center and at the Occupational Health Field Headquarters, (*b*) by other agencies of the Federal Government, and (*c*) by Public Health Service grantees and contractors.

At the Sanitary Engineering Center, the nationwide, aerometric survey begun approximately 2 years ago will be expanded. Preliminary estimates of classes and determinations of amounts of particulate loadings have been obtained from air samples collected on daily and weekly schedules in more than 30 representative

communities. These include both urban and rural areas. Inorganic assays and quantitative analyses of certain organic constituents are made of the present particulate collections, and it is planned to supplement these by routine determinations of some of the nonparticulate pollutants (gases and fumes) in the near future.

At the Occupational Health Field Headquarters, work is already under way in determining the physiological and toxicological effects of certain chemicals, such as ozone, oxides of nitrogen and sulfur, and complex hydrocarbons known to be present in smog.

Certain research problems in air pollution can be studied more advantageously and economically by other Federal Government agencies in addition to their regular activities because of staff competencies and special facilities which they possess. Thus, arrangements have been made to transfer funds for special projects to three such agencies.

The United States Weather Bureau will make basic studies of the meteorological factors governing diffusion and dispersion of pollutants in the atmosphere and develop techniques of forecasting critical meteorological conditions in relation to air pollution.

The National Bureau of Standards will develop methods for sampling and analysis of certain air pollutants about which little is known and study their chemical and physical nature and the reactions at sources and in the atmosphere which may combine, split, or otherwise modify them, creating different and perhaps more or less harmful compounds.

The Bureau of Mines, Department of the Interior, will investigate methods of incineration of combustible wastes, evaluate sulfur dioxide removal processes, determine the composition of and changes in automobile exhaust effluents, and participate in special community investigations.

Arrangements also are being made for the Veterans Administration to undertake statistical studies of their physical examinations, case histories, morbidity and mortality experience among veterans who are known to have had long residence under conditions of relatively high or low exposure to known types of air pollutants. This effort to obtain suggestive clues from retrospective data concerning impairments which may ensue from chronic, accumulative exposures would require many years of watchful waiting to detect by the methods of prospective epidemiology.

A similar study, on a contract basis, is planned with the Society of Actuaries with reference to medically impaired insurance policyholders.

Grants-in-Aid

All grants-in-aid authorized by the act are for research, training, or demonstration projects. There are no formula-type grants for general program support. Only research grants will be made during this fiscal year.

Of the $500,000 available for research grants in 1956, approximately $300,000 already has been committed for support of air pollution studies. Most of the research grants awarded so far have been for studies primarily related to the health effects of air pollutants. Investigations under way include broad epidemiological studies of the relation of human disease to air pollution, studies of the effects of specific contaminants such as fluorides and oxides of sulfur, and studies of physiological response to air pollutants.

It is expected that future research grant projects will include studies on the causes and prevention of air pollution as well as those concerned with its effects on health.

The Division of Research Grants, National Institutes of Health, administers the processing of research grants. The air pollution research grants program is somewhat different from similar programs of the Service. It is authorized by separate legislation which is not limited to health considerations, although these are of a high priority, but is sufficiently broad to cover any research related to the causes, effects, or control of community air pollution. Adequate liaison will be maintained with Federal agencies to avoid duplication with other grant or research programs relating to air pollution.

Contract Research Plans

The medical component of the community air pollution program is planning an extensive use

of contract research to provide information concerning the health effects of subacute exposures to pollutants suspected to be harmful. This is probably the most important single fact to ascertain. Thus far, it has been the most elusive since most air pollution control ordinances are written on the assumption that freedom from community air pollution will be healthful.

It is hoped that organ function tests, especially pulmonary and cardiovascular, can be devised for use on a mass basis. Such tests might be applied, according to conventional epidemiological patterns, to population groups comparable in all important respects except for their exposure to high or low levels of specific air pollution.

Similarly, chest X-ray surveys may be made along epidemiological lines to see whether lung cancer is more prevalent in populations exposed to continued, high levels of air pollution.

Efforts are also planned to determine whether tissue culture techniques offer a more sensitive indication of the toxicity of air pollutants than do intact test animals.

Contract research will be employed by the engineers for the development and construction of special equipment such as automatic, recording air analyzers capable of measuring several air pollutants simultaneously.

These are the tentative directions in which the air pollution program is now headed. As new facts become available, more of the research will probably shift from emphasis on causes and effects to ways and means of preventing or controlling community air pollution. In time, more of the funds may be used for demonstrations and training than for research.

In view of the complexities of the problems involved and the frustrating experiences in control efforts thus far, it seems unlikely that immediate or short-time results can be expected. The ad hoc committee was of the opinion that at least 2 years would be necessary to build up to the desirable level of research activity, and that 5 years of intensified effort at the maximum budgetary level specified by Public Law 159 would be required to produce research findings of major significance.

Research Factors In the Control Of Uterine Cancer

By Raymond F. Kaiser, M.D.
Chief, Field Investigations and Demonstrations Branch, National Cancer Institute

Since cancer presents no symptoms in the early stages, the development of a case-finding method for discovering uterine cancer in a really early stage of the disease represented a difficult research undertaking.

Thanks chiefly to the research efforts of Dr. George N. Papanicolaou, we have such a procedure today. This is the cytologic technique for examination of exfoliated cells in vaginal smears. The technique is based on the fact that since cancer cells do not adhere closely together, and consequently shed readily, with proper staining they can be distinguished microscopically in smears of vaginal secretions.

Papanicolaou Test

The Papanicolaou technique has been a long time coming to its present acceptance for a number of reasons.

The idea of studying the exfoliated cells in various secretions of the body is not new. Examination of the vaginal fluid was first performed by Pouchet more than 100 years ago. His interest, however, and that of many investigators who followed him, was related to analysis of the normal human sex cycle and to the problems of sex physiology.

Papanicolaou was also doing research in the field of sex physiology when in 1923 he first applied cytology to the diagnosis of uterine cancer. His new discovery was duly reported in the literature, but, despite this early recognition of the possibility of diagnosing uterine cancer by this means, the interest of clinicians in the potentialities of this diagnostic method was not aroused.

Possibly the fact that Papanicolaou was not a clinician but an anatomist working in a research field may have had some bearing on this lack of interest.

As a result of Papanicolaou's association in 1939 with Dr. Herbert F. Traut, and later with Dr. Andrew A. Marchetti, further investigations placed the use of vaginal smears in cancer diagnosis on a more solid basis. Papanicolaou and Marchetti introduced the endocervical and endometrial smear technique.

Following the close of World War II, reports by others began to appear in the literature recounting the use of this technique. Skepticism and doubt were expressed, particularly by pathologists, as to whether the technique could identify cancer cells. A portion of this resistance stemmed from the fact that by training and experience pathologists had learned to identify cancer on the basis of a section of tissue with a characteristic cell structure.

The numerous evaluations made of the accuracy and validity of the technique and the passage of time led to a change in the concepts of pathologists and an increasing acceptance of the technique as a diagnostic aid or screening technique for cancer.

Many clinical investigations have demonstrated that the Papanicolaou technique can indicate the probable existence of uterine cancer, particularly where the cervix is involved, even in the absence of significant signs or symptoms and without suggestive clinical evidence of the disease or gross findings.

Herein lies the greatest merit of the test. It permits the early recognition of incipient lesions such as carcinoma in situ, a microscopic lesion which is noninvasive and therefore 100 percent curable.

Here again there was reluctance to accept the findings, this time by the clinician. His resistance was based on the fact that for years uterine bleeding or spotting has been considered the cardinal sign of early cervical cancer. We now know that this is a sign of invasive cancer with ulceration rather than early carcinoma. Of necessity many studies and investigations had to be carried out to establish this fact.

As a consequence, the clinician's concept of early cervical cancer has gradually changed. In fact, at present it is believed that an appreciable number of cervical cancers pass through the carcinoma in situ stage before invasion begins.

The Memphis Study

The technique still faced the criticism that there would not be enough professional people to carry out the procedure. This situation led to the establishment in 1951 of a study in Memphis and Shelby County, Tenn., by the National Cancer Institute in cooperation with the University of Tennessee Medical School divisions of pathology and bacteriology and of obstetrics and gynecology, the Memphis and Shelby County Health Department, the Shelby County Medical Society, the Bluff City Medical Society, and the Shelby County unit of the American Cancer Society.

The purposes of the study were to determine the feasibility and practicality of vaginal cytology as a general population screening procedure; to determine age-specific incidence and prevalence rates for preinvasive and invasive cancer; and to determine the course and fate of carcinoma in situ.

Initially in this operation, nonprofessional persons, under the direction of a nurse, obtained the smears from clinic patients; a staff of cytology technicians screened the smears, sorting out the suspicious and positive smears from the negatives; pathologists made the final interpretation of the smears and carried out the tissue examination of biopsies resulting from the suspicious and positive smears.

Early in the program most of the smears came through clinics conducted throughout the area. With acceptance, an increasing number of smears came from private practitioners, and now more than half of the smears reviewed are from that source.

The results have been encouraging. The cytology findings of the first 70,000 women screened were suspicious or positive in 1,327 women or 1.9 percent. In this group 282 intraepithelial or carcinoma in situ cancers and 245 early invasive cancers were found. From the point of view of cancer control, it is especially significant that 88 percent of the intraepithelial and 29 percent of the invasive cancers were not suspected either by the physician or the patient.

Of the cancer found, intraepithelial cancer occurs in younger age groups with a peak of incidence about age 33. The peak incidence of the invasive cancer is at age 52. This suggests that cancer of the cervix may exist for varying periods of time in a noninvasive form when it is completely curable.

Mass Screening Potential

Experience indicates that the vaginal smear technique is an excellent procedure for finding cases of cancer. It will effectively screen out from the general population suspicious cases needing further study by biopsy, but a positive report on cytology examination is not a final diagnosis and biopsy examination must confirm the smear report before definitive therapy is carried out.

The many questions which remain concerning the control of uterine cancer can be answered only through additional investigations and research.

Research with the cytologic technique may answer questions that bear directly on the problem of controlling uterine cancer, questions such as:

- Does the carcinoma in situ lesion progress invariably to invasiveness?
- What is the true incidence and prevalence of the lesion?
- What is the earliest age at which the lesion occurs?
- Are there even earlier stages of the lesion?
- How many of these lesions regress spontaneously?
- What is the duration of the lesion before invasion?
- What is effective treatment for the lesion?
- Can improvement be made in the method of screening the smears?

Some of the research is already under way. One study relates to the development of an electronic device to mechanically sort out the large mass of negative smears from the positive and suspicious. Such a machine within the foreseeable future should greatly reduce the number of trained technicians required for a screening survey.

Answers to some of the other questions will be sought in 5 or 6 other pilot studies which we expect to establish throughout the country, principally in connection with medical centers.

Meanwhile our experience has led us to conclude that vaginal aspiration and cytologic examination of the smear are practical procedures for discovering cervical cancer on a mass basis. The widespread application of this technique could potentially reduce cervical cancer mortality.

Public Health Aspects Of Atomic Energy In Peacetime

By Daniel Bergsma, M.D., M.P.H.
New Jersey State Commissioner of Health and Vice President, Association of State and Territorial Health Officers

The emergence of the peacetime applications of nuclear energy is one of the beneficial concomitants of the development of nuclear weapons. Ionizing radiations are thus one more complexity that man has added to his environment. The consequent public health responsibility is to maintain all radiation exposure within the generally accepted limits without unnecessary interference with maximum utilization of radiation sources. Since its beginning in the early 1940's, the atomic energy industry has had a tremendous growth—first under the Manhattan Engineering District and then under its successor, the Atomic Energy Commission. The commission has capital assets of some $12 to $14 billion and an operating budget of almost $2 billion a year. Private firms manufacturing equipment and devices needed in atomic energy work have investments and yearly sales running into many millions of dollars.

The amounts of radioactive materials dealt with have also increased enormously. A medium-size nuclear reactor, for example, may contain in the order of 100 million curies of radioactive materials. It is necessary to process

chemically the fuel elements containing these vast quantities of radioactivity on a routine basis. In spite of this fact, the atomic energy industry has had a lost-time injury rate lower than any other major industry except communications. With the exception of a few accidents in connection with experimental work and the weapons testing program, no radiation injuries are known to have occurred.

Much of the Atomic Energy Commission's success in this respect is undoubtedly due to the enforcement of very conservative permissible exposure standards. The establishment of rigid control procedures at the inception of the atomic energy industry represents one of the few instances in which a major industry has set up a large program in health protection without the compulsion of a record of serious accidents.

Two Types of Hazards

The field of atomic energy presents two types of health hazards due to ionizing radiations.

The radioactive material may become airborne or may contaminate food or water and so may enter the body via the lungs or by ingestion. In this case, such factors as the metabolism of the element concerned, its physical and biological half-lives, and the type of radiation it emits must be taken into account in determining permissible body burdens. An element that tends to concentrate in a particular organ, as does iodine in the thyroid, will produce a different pattern of injury from an element that is nonspecific, such as carbon or sodium.

The gamma rays and the beta rays of radioactive material constitute an external radiation hazard. Beta rays are high-speed electrons which can cause a burn similar to a thermal burn in the skin but which do not affect the deeper layers of tissue. Gamma rays are identical with X-rays in their action but have somewhat higher energies than the common diagnostic X-ray. They are highly penetrating radiations and tend to expose the entire body, or major parts of it, more or less uniformly. The radiosensitivity of tissues and the relative efficiency of various radiations in causing biological damage must be considered in setting permissible exposure limits.

Public health problems can arise under conditions of use of radioactive materials and under conditions of their ultimate disposal. In the first instance, exposure may result from external sources of radiation or from ingested or inhaled contaminants. Depending on the method of disposal, this may also be true of the second instance. However, a significant difference exists in that under conditions of use the material is presumably under the control of the user, whereas under conditions of ultimate disposal the material has passed beyond, or is only partially under, the user's control.

Problems of Use

One of the chief ways in which a public health problem may arise under conditions of use is the accidental release to the atmosphere or to the local liquid disposal system of radioactive materials. The release of radioactive material into the air or the disposal system is allowable provided the amount does not exceed permissible limits established by the Atomic Energy Commission. Small quantities are generally disposed of by sufficient dilution to keep resultant radiation levels below permissible limits. However, there is always the chance that malfunctioning of equipment or error on the part of personnel will allow the release of much larger quantities. In an effort to avoid this possibility, monitoring devices are commonly used in the effluent stream.

There is also the possibility of malfunctioning of the monitoring devices, and, in any event, the actual amount of dilution taking place remains a question. Therefore, it is necessary to measure radioactivity levels of air and water in downwind or downstream locations.

Since there may be appreciable variation in background, or natural, radioactivity from area to area, it is desirable that information on these levels be collected for various sections of a State. Where there is a major atomic energy installation, such as a nuclear reactor, it is sound practice to make a rather extensive investigation of the natural activity in the surrounding region, including soil and vegetation as well as air and water. The collection of data on background radiation should be started well

in advance of the time the reactor begins operation so that the data will be representative of seasonal weather conditions, and it should be continued long enough after reactor startup to enable the selection of sampling locations that will provide the most useful data. Subsequent samples from these locations will give a good indication of whether or not the installation is contributing any increase of activity to the naturally existent levels.

Such sampling will normally be conducted by the operators of the installation. However, for its own knowledge the responsible State agency should conduct spot checks of its own.

Disposal Problems

Under conditions of ultimate disposal, the wastes are far larger in volume, and activity levels are tremendously higher. These wastes will probably be due almost entirely to the chemical processing of reactor fuel elements. They may contain activity concentrations of several hundred curies per gallon. A further complication is introduced by the fact that a heat release of 2 or 3 British thermal units per hour per gallon of waste occurs as a result of the heat generated by the intense radiation. The higher the concentration of radioactivity, the higher the rate of heat release per unit volume and the greater the associated handling problems. Tanks containing highly concentrated wastes must be cooled to keep the liquid from boiling. Cooling of wastes adds substantially to the water demands of the installation.

Treatments which are effective in reducing or eliminating the toxic qualities of chemical wastes have no value whatsoever in dealing with radioactive wastes. The only method of disposing of radioactive wastes is by physical transfer from locations where they may be hazardous to areas where they will present no great threat. There is no chemical, physical, or biological means by which these materials can be made inactive or by which the rate of decay can be hastened. They can be made easier to handle by such methods as concentrating liquid volumes by evaporation or by making shipments in a number of small volumes to reduce shielding bulk.

At present, disposal of low-level wastes is by dilution to a safe level. This is obviously impractical with high-level wastes, since they would require dilutions of the order of 1 million gallons or more for each gallon of radioactive waste.

Several alternative solutions for high-level wastes have been suggested. Among these are pumping the wastes into permeable subsurface soils or into deep salt-bed formations. The theory behind these proposals is that the movement of ground water through such formations is so slow that a very large reduction in the amount of radioactivity would take place through natural decay before the activity could enter sources of potable water. Unfortunately, suitable geological formations are not located beneath the most convenient sites for processing plants.

Another proposal is to dump wastes in the oceans. The wastes would either be placed in suitable containers and allowed to sink to the bottom in about 1,000 fathoms of water, or they would be pumped to the bottom as liquids. Unfortunately, on the east coast of the United States the continental shelf extends many miles to sea, and our knowledge of deep ocean currents at present is not sufficient to enable accurate predictions of what the resultant dilution would be.

Because of the uncertainties involved in these proposed methods, the present solution is to store the wastes for years in underground tanks. In spite of precautions, it is always possible that such tanks may develop leaks and contaminate water supplies. Underground burial of solid wastes presents the same potential hazard. The problem of safe disposal of these wastes may well prove to be the limiting factor in the construction and operation of power reactors. If such wastes become free in the ground, they are beyond control. This problem may be one of the most critical facing us in public health.

A great deal of what has just been said relates specifically to nuclear reactors. A second large sphere of public health concern must be installations which are using radioisotopes for research and industrial purposes. Radioisotopes are presently available, not only from nuclear reactors, but also from particle accelerators.

AEC Control

Under the Atomic Energy Act of 1954, the distribution of all special nuclear material, source material, and byproduct material is controlled by the Atomic Energy Commission. By definition, special nuclear material refers to plutonium or uranium enriched in the isotope 233 or in the isotope 235. Source material is defined as natural uranium or thorium. Byproduct material includes all radioactive materials produced in the uranium by the process of nuclear fission and all substances made radioactive by exposure to the radiations resulting from the operation of a nuclear reactor.

Concerning control of byproduct materials, the material of interest in this discussion, the Atomic Energy Act of 1954 also states that "no person may transfer or receive in interstate commerce, manufacture, produce, transfer, acquire, own, possess, import, or export any byproduct material," except under a license issued by the AEC. The act further states: "The Commission shall not permit the distribution of any byproduct material to any licensee, and shall recall or order the recall of any distributed material from any licensee, who is not equipped to observe or who fails to observe such safety standards to protect health as may be established by the Commission or who uses such material in violation of law or regulation of the Commission or in a manner other than as disclosed in the application therefor or approved by the Commission."

The necessity of obtaining a license before purchasing radioactive materials from the AEC or its licensees has been extended by the commission to cover radioactive materials produced in particle accelerators, providing these machines were built fully or in part with Federal funds. (Particle accelerators are important because in them it is possible to produce radioisotopes which cannot be formed in a nuclear reactor.) If an accelerator is built with private funds, however, the AEC has no authority over the isotopes so produced, nor has it any say in controlling radiation levels around the accelerators while they are in operation. The Nuclear Science and Engineering Corporation recently announced the inauguration of the first private program for the production and supply of cyclotron-produced isotopes (a cyclotron is one type of particle accelerator). Procurement of these materials from this firm will not require AEC licensing or approval. Of course, interstate shipments of these materials will have to meet regulations governing the transportation of radioactive substances.

State Responsibilities

The Atomic Energy Act in no way interferes with the power of the States to promulgate necessary or desirable rules and regulations. Since there is now at least one source of radioisotopes not subject to AEC control, and since such sources of radiation as X-ray machines and radium salts never have come under commission control, it may be that rules and regulations will have to be set up. When and if this is done, every effort should be made to maintain conformity with the recommendations of the National Committee on Radiation Protection and the requirements of the Atomic Energy Commission in order to avoid the chaotic situation that would result from 48 sets of incompatible regulations.

The Atomic Energy Commission, by virtue of its years of experience and the tremendous amount of research it conducts, is far better equipped than the individual States to formulate standards for maximum permissible concentrations in air and water, and for maximum permissible exposures to external radiation. But the State agencies can better carry on the actual regulatory and inspection functions. The commission performs these functions at present only because, having been directed to encourage the peacetime development of atomic energy, it felt it mandatory to safeguard the public health in the process. It is highly probable that the commission will be willing to relinquish much of this responsibility whenever a State agency demonstrates its readiness and ability to accept it.

The logical development of the regulation of isotope users would be the emergence of a relationship between State and local agencies and the Atomic Energy Commission parallel to that between the State and local health agencies and the Public Health Service. Where particular situations arise requiring specialized knowledge or facilities, the Atomic Energy Commission is available for consultation and assistance.

The Current Status Of Hospital Survey And Construction Programs

By John W. Cronin, M.D.
Chief, Division of Hospital and Medical Facilities,
Public Health Service

Substantial progress has been made since the Hospital Survey and Construction Program was authorized in 1946. At that time the national bed deficit was in excess of 900,000. We now have 260,000 more acceptable hospital beds; 88,000 were constructed and put in operation through the Hospital Survey and Construction (Hill-Burton) Program.

The net gain since 1946 is much less than the total volume. In fact, it is only 70,000 beds, or less than 8 percent of the present estimated needs. This is influenced by the mounting obsolescence—physical and functional—and annual population increase. We have 73 percent of the general beds but only 56 percent of mental beds and 14 percent of chronic beds needed.

About one-third of all present hospital construction is through the Hill-Burton program. There are regional differences in volume of construction, which varies according to the average income of the area. Hill-Burton projects account for nearly all the construction undertaken in the lowest income areas but constitute only one-fifth of that in the wealthiest areas. This follows the basic intent to provide maximum aid to low-income States.

Some of the specific gains from the program include 2,600 approved projects which will provide 121,000 beds, and 1,900 completed projects which have provided 88,000 beds. In addition, 550 health centers, many related health facilities, and State health laboratories have been aided in their construction phases.

Progress in acquiring facilities in local areas may be measured by comparing 1946 figures, showing that 10 million people in 600 general hospital service areas did not have access to acceptable hospital beds, with the current figures of 175 areas and 3 million people. However, there remain 336 other hospital service areas in which less than 50 percent of the total bed need has been met for a population of 23 million.

Specific illustration can be cited. In Alabama, the number of counties without acceptable general hospital beds has been reduced from 33 to 2, although 25 counties still have less than 50 percent of the need met.

Other benefits from the Hill-Burton program include assistance to teaching hospitals approved for intern and residency training, new teaching hospital facilities at university medical centers, improved design of hospital and related health facilities, new and better hospital licensure laws, minimum standards of hospital operation and maintenance established in all States, increased attention to related health facilities, and the development of an orderly system of planning for and providing hospitals and related facilities.

Six hundred communities now have hospitals where none existed previously. The nearly 800 new hospitals built in towns of less than 5,000 may serve well as evacuation destinations for critical areas in times of national catastrophe.

The 1954 Amendments

The Medical Facilities Survey and Construction Act of 1954, amending the Hospital Survey and Construction Act, provides an inducement for the construction of facilities urgently needed for patients suffering from chronic illness and impairments as well as an inducement to the development of diagnostic and treatment centers and rehabilitation facilities.

Federal allotments to the States were earmarked for these specific types of facilities. The act obligates the States to make a survey of need. The appropriation is available through June 30, 1957.

Following the development of the Federal regulations and their promulgation in January 1955, the States began surveys relating to the new program, and by November 32 States

have had their plans approved for hospitals and 25 States for medical facilities.

The 1954 legislation is designed to emphasize the planning and construction of hospital-related medical facilities. Despite the increase in general hospital beds, people suffering from prolonged illness still had difficulty in obtaining care in facilities adequate to meet their needs and within their ability to pay. The need for less expensive facilities is, of course, only an indication of increasing requirement for such facilities. The demand stems from the aging of our population and its consequences in terms of increases in chronic diseases.

Present Developments

The 25 State plans for medical facilities reflect an interest on the part of the States in coordinating hospitals and medical facilities. Certain categories which represent services rather than definable units, such as a hospital or nursing home, present problems, which will ultimately be solved as experience is gained.

For the most part, diagnostic and treatment centers are being planned in relation to general hospital service areas.

It is evident that a significant amount of services to ambulatory patients is being provided in hospitals, clinics, and public health centers, particularly the specialized clinics for psychiatric, cancer, heart, dental, and tuberculous patients. In an effort to bring basic general hospital services to the patient in his own community, most of the State plans provide for diagnosis and treatment centers initially in general hospitals or as an expansion of the outpatient departments.

The more specialized services are being planned in centers where there are large general hospitals and a concentration of population. The States are still groping for the solution in communities too small to support a general hospital. Only a few States are making provisions for free-standing diagnostic and treatment centers in such communities. With few exceptions, the State planning agencies recognize the tentative nature of the planning for diagnostic and treatment centers. They propose with experience to refine this aspect of their program in subsequent annual revisions.

Because a specific unit can be defined, the nursing home category seems to present less of a problem. Nevertheless some problems have appeared.

In most States the nursing home operators have felt that licensing by the State is evidence of meeting the required standards. The problem of interpreting what is meant by skilled nursing care is still with us. Planning for nursing homes, like that for diagnostic and treatment centers, is taking place in relation to the general hospital service area. Some criticism has developed with respect to the range of the bed ratio adopted for nursing homes. The majority of State plans use 3 beds per 1,000 population, but some groups believe this ratio is unrealistically high.

The problems with respect to chronic disease hospitals have not been as difficult because the States have had some experience. In some State plans, facilities previously designated as chronic disease hospitals are now shown as nursing homes. There is evidence of increasing development of means of distinguishing between chronic disease hospitals and nursing homes and of defining the services in each. Planning in this category is primarily centered on development of services for the chronically ill in large general hospitals.

With respect to rehabilitation facilities, the inventories fail to reflect the total rehabilitation resources within the States. Often occupational therapy and physiotherapy in hospital clinics are not identified.

Rehabilitation facilities for the most part are being programed at medical schools and medical centers. The majority of State plans, however, allocate all the facilities permitted under the ratios in the Federal regulations for this category. This may not be realistic. It would seem that comprehensive rehabilitation facilities as programed at universities and medical centers would be the more reasonable solution since, in our present state of knowledge, it is important to train rehabilitation workers.

Need for Wise Planning

We need to develop understanding about these new programs—in the States as well as among

ourselves. We shall have to plan carefully: How much? how long? and how fast?

The basic program requirements for hospital and medical facilities have been affected by significant changes in the levels of hospital utilization and by reduction in the length of stay resulting from improvement in treatment and new medical discoveries. We shall need to plan wisely in relation to changes resulting from improvements and discoveries.

Fortunately, the 84th Congress has made available hospital research grant funds. These present opportunities to solve a host of hospital and related health problems through common effort. I would say that nothing is more needed than research on what is good care and what quantity of it is needed.

Food and Drug Projects Of Interest to State Health Officers

By Jack M. Curtis, Ph.D.
Assistant Chief,
Division of Pharmacology,
Food and Drug Administration

Many programs of the Food and Drug Administration follow lines that are identical with the interests of State health officers. My purpose is to outline some of these programs as a means of directing attention to areas of mutual interest. This may help State health officers to exploit the resources of the Food and Drug Administration in their work of protecting public health.

Protection Against Poisoning

One of the primary concerns of the Food and Drug Administration has been protection against poisoning—the acute, obvious poisonings contemplated by the Caustic Poisons Act as well as the chronic, subtle poisonings that may arise through the inclusion of chemicals in foods.

A growing concern over the public health hazards of numerous industrial and household chemicals is reflected by the activity of many national health organizations. The increasing number of the various household products containing hazardous chemicals makes it difficult for the family physician to keep abreast of the toxic substances and to recognize them by trade name.

The American Academy of Pediatrics, local health officers, the Food and Drug Administration, and the Public Health Service are working toward the formation in many large cities of poison centers that will accumulate data concerning the poisons that most frequently cause disastrous results. The centers will be ready on a 24-hour basis to advise physicians as to the type of antidoting that is appropriate.

In conjunction with the American Association of Medical Record Librarians, the Food and Drug Administration is studying methods whereby pilot studies can be set up in hospitals for the purpose of reporting untoward effects caused by therapeutic agents.

All of this information will help in pinpointing the toxic substances that are most important, in recommending more informative labeling, and in producing the basic data necessary to support any modification of existing laws.

We are also interested in the type of poisoning—to use the word in its broadest sense—which is caused by the misuse of potent drugs, particularly barbiturates and amphetamines. The problem is what can we do about the excessive use of barbiturates, resulting in suicides, accidental deaths, moral degeneration, or about the chronic use of excessive amounts.

It is illegal to sell these potent drugs except as directed by the prescription of a licensed practitioner. Only a very small number of pharmacists dispense the drugs indiscriminately. A still smaller number of physicians contribute to their pernicious misuse. But distribution outside licensed drug channels is increasing. In terms of the number of doses, the outlet by these various sources is tremendous.

The Food and Drug Administration investigates the illegal actions of druggists or physicians only on information from physicians, local police departments, health officers, or the

relatives of individuals that misuse drugs. Top priority is given to reports of the illicit distribution of barbiturates.

This type of investigation is a profitable opportunity for cooperation between State health officers and the Administration. To the extent that it is feasible under State laws, we are anxious to coordinate our activities with those of the States so that the consumer can be effectively protected.

Regulating Medical Quackery

Our efforts to control medical quackery continue to be very difficult. Since the Food and Drug Act does not regulate the practice of medicine, our approach toward the control of medical quackery must be directed at the drugs or devices used in the treatment of disease. Our activity is necessarily limited to situations involving interstate shipment of drugs. The adequate control of medical quacks seems to be basically a State responsibility.

At the trial of the case against the Hoxsey Cancer Clinic in Texas, which culminated in the issuance of an injunction in October 1953, it was testified that more than 6,000 patients had come to the clinic in a 2-year period. The injunction prohibited the interstate shipment of the various drugs used in Hoxsey's supposed treatment of cancer.

More recently, a Hoxsey cancer treatment center in Pennsylvania has opened, with the backing of influential local people. Action has been taken against the center, but legal delays have slowed up enforcement results.

On November 7, 1955, the Texas State Board of Medical Examiners revoked the licenses of 6 osteopaths and 1 medical doctor associated with the Hoxsey clinic, finding them guilty of "unprofessional" and "dishonorable" conduct. Their attorney has announced he will appeal.

If the States could "nip in the bud" the promoters of fake drugs and devices, they would be serving their citizens well and at the same time they might prevent the growth of a formidable fraud.

The Electronic Medical Foundation of San Francisco consented to an injunction in March 1954 against the shipping of 13 different types of electronic devices used for the diagnosis and treatment of serious diseases.

Among the devices was one represented as a "tuning apparatus" by which it was supposedly possible to distinguish the alleged characteristic radio frequencies associated with different diseases. Called a Radioscope, the apparatus had dials, lights, wires, and a slot in which could be placed a specimen carrier of filter paper bearing dried blood of a patient. Investigation showed that this blood diagnostic service was incapable of distinguishing the blood of animals or birds from that of man or that of the living from the dead. Diagnostic "readings" from this machine were sent to local practitioners with instructions for treatment by other machines also supplied by the foundation. More than 5,000 of the treatment machines had been distributed at the time of the injunction decree.

Antibiotics and Food

The administration of antibiotics and hormones to animals, which later will be used as food for man, is a special segment of the problem of chemical additives in food. The feeding of low levels of antibiotics to animals has not resulted in the deposition of any appreciable residue of antibiotics in the tissues of these animals, but the use of larger quantities of antibiotics for the treatment of disease, such as the treatment of mastitis in cattle by intermammary infusion, has caused concern.

This problem was recognized first in the cheese industry when starter colonies would not grow in milk collected from animals so treated.

The Food and Drug Administration found positive results of penicillin in 3.2 percent of 94 samples of milk collected throughout the United Sates in 1954. In 1955, 11.6 percent of 474 samples of milk from all parts of the country were found to be positive for penicillin. The actual amounts were quite small and they were regarded by authorities on antibiotics as unlikely to change oral or intestinal flora or to provoke sensitization in a nonsensitive consumer.

Although the evidence is not adequate for definite conclusions, State dairy sanitarians

should be aware of the apparent trend of increasing amounts of antibiotics in milk.

The use of antibiotics as preservatives for food products is being investigated, for this is a field of development that may well bear careful watching.

Suggestions have been made that antibiotics be used as a spray on vegetables to inhibit rot after harvest, that chickens, after having been picked and cleaned, should be soaked in solutions containing an antibiotic to preserve them from spoilage while in transit and storage, and that antibiotics should be incorporated in the ice which is used to ice shrimp on their way to the market. None of these suggestions has been supported by sufficient experimental evidence to show that the antibiotic is not present in the food when it is consumed.

The growing practice of treating farm animals with hormones, particularly diethylstilbestrol, is justified by the economic advantage to be derived from improved quality or increased rate of growth and increased efficiency of feed utilization. Stilbestrol may be administered either in pellet form, implanted subcutaneously as is ordinarily done in chickens, or incorporated in the food as it is usually administered to cattle.

In chickens the drug causes a redistribution of fat, producing a plump, well-rounded carcass, easily and cleanly defeathered and of high quality. The effect on growth is slight. In cattle, on the other hand, the effect on growth is quite pronounced. Increases of growth of about 20 percent have been reported, along with a decreased feed consumption of about 15 percent. Usually, the carcass quality is about one grade lower.

The mechanism by which these changes take place is not clear. There is evidence that stilbestrol, whether it be fed or administered in pellet form, increases nitrogen retention in cattle. Furthermore, hypertrophy of the liver, of the adrenal glands, and of the pituitary without specific cellular changes has been reported. These observations seem to indicate a change in the endocrine gland metabolism, but exactly how these changes produce the increasing growth rate and increase in efficiency of food utilization is not clear.

The Food and Drug Administration has required the manufacturers of stilbestrol-containing feed supplements for cattle to submit extensive evidence that no added estrogen is in the edible portions of steers which have been fed these supplements. When this work was repeated in the laboratories of the Food and Drug Administration, it was shown that meat from steers fed 10 milligrams of stilbestrol a day contained not more than 0.6 parts per billion estrogenic activity when ready for market.

Therefore, it may be stated with considerable confidence that stilbestrol fed to steers under the conditions outlined by manufacturers of feed supplements will constitute no hazard as an additive to food products derived from animals thus fed.

Another problem concerns feeds prepared for small laboratory animals when the feeds have been run through mixers immediately following stilbestrol-containing feeds for steers. The result has been an accidental contamination of the small animal feeds with stilbestrol, which, in some cases, has quite serious effects upon the reproductive capacity of small animal colonies. Also, the results of hormonal assays would be erroneous if the experimental animals received this contaminated food.

The exact method of controlling such contamination and preventing its occurrence is under study by the Food and Drug Administration.

Pesticidal Residues

The basic philosophy of control of pesticidal residues was changed somewhat by the passage of the pesticide chemicals amendment in 1954. Under this law, after the Secretary of Agriculture has certified that a pesticide is useful, application may be made to the Food and Drug Administration to establish tolerances or exemptions for the chemical, supported by data to establish that these tolerances are safe to the consumer. The type of data required is of interest.

The acute toxicity of the chemical is of value in appraising the hazards to those who handle or apply it.

The biochemistry of the compound including data on its absorption, excretion, storage, and metabolism is essential in evaluating the magni-

tude of the hazards to the consumer when residues of the chemical remain on food. For example, it has been found that during the usual process of detoxification of heptachlor, an epoxy derivative that was produced was three times as toxic to animals as the original pesticide.

Next, the chronic toxicity of the chemical is required. This involves a 2-year feeding study in rats and, if necessary, rather prolonged studies in another species of animal, usually the dog.

Finally, there is a pathological examination of the organs of these experimental animals in order to locate the site and to determine the extent of injury produced.

All these data are then considered together to arrive at a tolerance that will protect the sick, the healthy, the young, the old. This tolerance includes a safety factor that is designed to permit a maximum intake of the chemical from all possible sources that is no greater than one one-hundredth of the largest dose that is known to produce no injury to the experimental animal.

The various tolerances as they are determined are published in the *Federal Register*, but to provide this information in a more convenient form the Administration provides a looseleaf service entitled "Summary of Tolerances and Exemptions for Residues of Pesticide Chemicals."

Diseased Poultry Inspection

The sanitation of poultry dressing plants and the antemortem and postmortem inspection of poultry to eliminate diseased birds from channels of commerce are problems that have been considered before by the Association of State and Territorial Health Officers.

An advisory panel of outstanding poultry pathologists and research workers has met with members of the Food and Drug Administration and the Public Health Service to make recommendations regarding inspection procedures and the disposition of diseased poultry. As a result, there is in preparation a manual of inspection procedures.

Civil Defense Activities

The food and drug program relating to civil defense has been developed along educational and technical lines. Courses of instruction in methods of inspection when contamination with radioactivity is suspected are now being given throughout the country and will be continued throughout fiscal 1956. Each of our 16 districts has been supplied with the necessary items of equipment to measure radioactive contamination and has been instructed in their use.

Representative samples of both food and drugs have been exposed to atomic blast to determine its effect on them. In only two drug products, insulin and vitamin B_{12}, did the potency deteriorate. Glass containers were discolored and, if close enough to the blast, became radioactive. Since studies of the food exposed more recently have not been completed, about all that can be said is that the foods have an off taste. When radioactivity was induced it seemed to be related to the phosphorus concentration in the food. Further feeding studies are under way.

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NOTE: *Since this paper was delivered, evidence has been submitted to prove the absence of a chlortetracycline residue in cooked but not in fresh poultry which had been chilled in water containing 10 p.p.m. of the antibiotic.*

Willamette Valley Chest X-ray Survey

By GORDON C. EDWARDS, M.D., M.P.H.

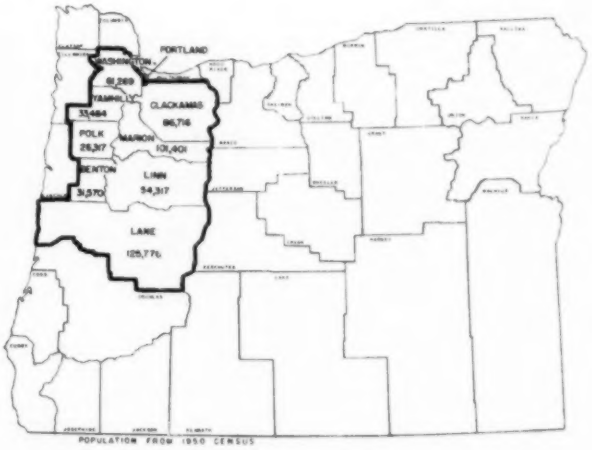
THE WILLAMETTE VALLEY chest X-ray survey in 1951 was the first attempt in the United States at conducting a large-scale rapid-tempo communitywide chest X-ray survey in a relatively sparsely populated, predominantly rural area. It was the 16th large-scale survey undertaken through use of the survey equipment and personnel available by loan from the Public Health Service.

This report is intended to be an objective appraisal of the findings of the Willamette Valley chest X-ray survey, based on a study of the final postsurvey diagnoses supplied by the private physicians examining survey cases referred for followup because of suspect chest X-ray findings.

A number of rapid-tempo mass chest X-ray surveys have been reported in the past, including such large-scale operations as Los Angeles, Boston, and Cleveland. A similar report, in limited publication, was made shortly after conclusion of the Willamette Valley survey by the Report Committee of the Willamette Valley Chest X-ray Survey, Inc. Survey findings in that report were based on a statistical analysis of readings of 70-mm. and 14″ x 17″ retake screening X-rays taken during the survey, but it lacked the essential element of clinical appraisal for definitive diagnosis. The present report includes this all-important feature.

Dr. Edwards, with the Oregon State Board of Health since 1946, has been director of the division of preventive medical services since 1950.

The survey area included eight Oregon Willamette Valley counties: Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, and Yamhill. Excluded, however, were Multnomah County and its county seat, the city of Portland. The eight counties chosen cover an area of about 13,000 square miles, larger by far than many States, and contained a population



of about 520,850 persons, almost wholly white and largely American born. The region lies between the coast range on the west, the Cascade Mountains on the east, and the foothills of these two mountain ranges on the south, and is traversed through its length by the Willamette River, emptying into the Columbia River which forms the valley's northern border. It has been called the garden of Oregon and was the lodestone that drew and still draws thousands westward to its fertile soil.

Southernmost in the valley and largest of the

survey counties in area and population is Lane County with its city of Eugene, home of the University of Oregon. Lying north of Lane are Linn, Benton, Marion, Polk, Yamhill, Washington, and Clackamas Counties, the latter two extending to the Portland metropolitan area. Corvallis, county seat of Benton County, is the site of Oregon State College, while the Oregon College of Education is located at Monmouth in Polk County. Salem, the State capital, is also the county seat of Marion County. The outline map of Oregon shows the survey area and the populations of the counties involved.

The Operation

The actual survey operation time was between July 17 and October 24, 1951. Details on planning and operation of the survey were given

Table 1. Number and percent of males X-rayed, by age and county,[1] Willamette Valley chest X-ray survey, 1951

[Based on 10-percent sample of 70-mm. film registrations]

County	Under 15	15–24	25–34	35–44	45–54	55–64	65+	Unknown age	Total [2]
Benton									
Number	250	2, 440	1, 550	1, 070	930	480	470	20	7, 210
Percent	6. 4	54. 8	50. 6	61. 7	68. 1	43. 0	48. 5	----------	43. 5
Clackamas									
Number	580	2, 790	2, 290	2, 920	2, 170	1, 520	1, 520	100	13, 890
Percent	4. 6	53. 8	37. 9	45. 7	40. 4	34. 4	37. 1	----------	31. 5
Lane									
Number	720	6, 100	6, 390	6, 210	4, 560	3, 070	1, 890	220	29, 160
Percent	3. 9	62. 3	60. 3	66. 1	64. 2	60. 5	43. 5	----------	45. 1
Linn									
Number	180	2, 450	2, 880	2, 470	1, 780	1, 210	830	20	11, 820
Percent	2. 1	68. 2	68. 0	60. 5	61. 1	53. 4	41. 0	----------	42. 5
Marion									
Number	710	5, 350	5, 450	5, 010	3, 910	2, 860	2, 190	150	25, 630
Percent	5. 3	73. 2	73. 5	70. 6	65. 3	57. 0	45. 2	----------	50. 1
Polk									
Number	160	1, 500	1, 500	1, 180	950	800	660	60	6, 810
Percent	4. 0	75. 1	78. 7	63. 3	65. 1	67. 9	61. 9	----------	50. 5
Washington									
Number	440	2, 410	2, 310	2, 330	1, 530	1, 200	1, 200	120	11, 540
Percent	5. 0	61. 5	52. 5	52. 9	40. 7	38. 5	41. 3	----------	36. 9
Yamhill									
Number	50	1, 740	1, 380	1, 440	1, 340	1, 140	920	40	8, 050
Percent	1. 1	68. 2	61. 1	66. 0	71. 2	72. 8	52. 7	----------	47. 6
Valley									
Number	3, 090	24, 780	23, 750	22, 630	17, 170	12, 280	9, 680	730	114, 110
Percent	4. 1	63. 9	59. 5	60. 9	57. 5	51. 7	44. 0	----------	42. 9

[1] Estimated number X-rayed varies slightly from totals in tables 3 and 5, which are enumerated by the survey units. Discrepancies are mainly due to loss of approximately 850 registration cards in Clackamas County.

[2] These percentages are decreased by inclusion of the under age 15 group, who were X-rayed only on specific request of, and referral from, a physician.

in the report, "Viewing the Valley," published by the Willamette Valley Chest X-ray, Inc., in 1952. The Public Health Service supplied 18 mobile X-ray units, film, processing materials and operating personnel, physicians to read films, clerical staff for record and statistical services, and consultation. In addition, two X-ray units of the Oregon State Board of Health, with operating personnel, participated in the survey, and many professional and lay individuals at both State and local levels participated on a full-time or part-time basis.

Each of the eight participating counties was separately and independently organized, each with its own county executive committee and chairman. The medical society, health department, and tuberculosis and health association in each county served as sponsoring agencies, inviting the active participation and help of all other groups, agencies, and individual citizens

Table 2. Number and percent of females X-rayed, by age and county,[1] Willamette Valley chest X-ray survey, 1951

[Based on 10-percent sample of 70-mm. registrations]

County	Under 15	15–24	25–34	35–44	45–54	55–64	65+	Unknown age	Total [2]
Benton									
Number	270	2,060	1,420	1,260	1,020	760	520	30	7,340
Percent	7.2	59.8	58.8	74.8	73.6	64.8	46.8		49.0
Clackamas									
Number	650	3,180	3,330	3,000	2,140	1,480	1,130	160	15,070
Percent	5.5	58.9	52.2	46.8	42.6	38.1	30.8		35.3
Lane									
Number	890	7,260	7,200	6,460	4,440	3,110	1,780	150	31,290
Percent	5.2	72.5	70.5	75.3	70.7	66.4	43.0		51.2
Linn									
Number	150	3,020	3,260	2,460	1,620	1,170	810	40	12,530
Percent	1.8	80.0	76.2	66.2	64.5	59.4	42.4		47.3
Marion									
Number	810	6,260	5,090	5,740	4,230	3,200	2,200	140	27,670
Percent	6.4	85.5	70.8	81.6	71.4	63.8	43.1		55.1
Polk									
Number	170	1,690	1,270	1,100	990	670	500	10	6,400
Percent	4.4	85.4	65.8	63.9	74.4	63.2	50.0		49.8
Washington									
Number	490	2,800	2,750	2,640	1,880	1,260	710	30	12,560
Percent	5.9	71.9	61.2	59.2	53.0	45.2	27.8		41.8
Yamhill									
Number	60	2,180	1,440	1,750	1,290	1,100	970	50	8,840
Percent	1.3	88.7	63.3	81.9	71.2	68.6	58.5		53.5
Valley									
Number	3,490	28,450	25,760	24,410	17,610	12,750	8,620	610	121,700
Percent	5.0	74.3	65.7	68.3	63.3	57.5	40.8		47.8

[1] Estimated number X-rayed varies slightly from totals in tables 3 and 5, which are enumerated by the survey units. Discrepancies are mainly due to loss of approximately 850 registration cards in Clackamas County.

[2] These percentages are decreased by inclusion of the under age 15 group, who were X-rayed only on specific request of, and referral from, a physician.

Table 3. X-ray findings, Willamette Valley chest X-ray survey, 1951

Status	Valley total	Benton	Clackamas	Lane	Linn	Marion	Polk	Washington	Yamhill
Total small films taken	237, 229	14, 608	29, 816	60, 525	24, 446	53, 519	13, 233	24, 126	16, 956
Estimated number persons eligible for X-ray	375, 815	23, 911	62, 253	90, 245	37, 279	75, 271	18, 494	44, 235	24, 127
Small films taken as percentage of eligible	63. 1	61. 1	47. 9	67. 1	65. 6	71. 1	71. 6	54. 5	70. 3
Abnormal findings (70 mm.)	[1] 7, 415	327	961	1, 723	737	1, 687	508	636	578
Suspect tuberculosis	[2] 4, 222	202	574	1, 010	393	923	278	345	331
Suspect other chest pathology	[3] 2, 846	112	353	630	316	662	199	265	224
Suspect cardiovascular disease	[4] 347	13	34	83	28	102	31	26	23
Duplications, represented in abnormal total	22	0	1	6	1	3	4	3	4
Total individuals recalled	[5] 7, 393	327	960	1, 717	736	1, 684	504	633	574
Individuals responding	[6] 6, 686	307	860	1, 602	677	1, 551	482	584	539
Individuals not responding	[7] 707	20	100	115	59	133	22	49	35
Total individuals returning for retake	[*8] 6, 822	307	866	1, 670	682	1, 576	506	589	541
Number with cardiac interview only (14″ x 17″ films)	[9] 262	9	18	72	22	74	30	19	15
Total confirmatory films read	[10] 6, 560	298	848	1, 598	660	1, 502	476	570	526
Essentially negative	[11] 1, 986	76	298	467	195	439	151	169	163
Evidence of old healed disease including nontuberculosis	[12] 1, 797	73	194	398	227	433	123	145	187

NOTE: Footnoted figures include the following numbers of persons with residence outside the valley: [1] 258; [2] 166; [3] 85; [4] 7; [5] 258; [6] 84; [7] 174; [8] 85; [9] 3; [10] 82; [11] 28; [12] 17.
* Includes 136 individuals with unsatisfactory or negative 70-mm. films who came in for a 14″ x 17″ film.

in the community. Valleywide coordination and cooperation was obtained by setting up the Willamette Valley Chest X-ray Survey, Inc., with headquarters in Salem and a board of directors consisting of the chairmen of the principal valleywide committees and the general chairman from each participating county, plus State representation from the Oregon State Board of Health, Tuberculosis and Health Association, Heart Association, and Cancer Society. A survey director for the entire valley was appointed to direct and coordinate operations.

The Policy

Overall survey policy was established by the executive committee and board of directors of Willamette Valley Chest X-ray Survey, Inc. Professional policy regarding criteria for interpretation of X-ray films, criteria for recall for 14″ x 17″ film retakes, interview procedures in retake centers, and referral methods were developed by a Professional Policies Committee, with representation from the county medical societies and health departments involved and chaired by a member of the Tuberculosis Committee of the Oregon State Medical Society.

All suspect chest pathologies except cardiovascular were recalled for 14″ x 17″ film recheck. All suspects on 14″ x 17″ film retakes were referred to their private physicians for further study and definitive diagnosis. Epidemiological followup was a responsibility of the local health department in the area of residence of the suspect. Chest pathology other than tuberculosis was followed only to the point of establishment of medical consultation although all physicians of referral were queried through a specially developed epidemiological report form to obtain final diagnosis. Diagnoses other than tuberculosis were supplied by physicians on a purely cooperative basis since the majority of conditions involved (such as neoplasm and heart disease) are not reportable in Oregon.

The Population Involved

The aim of the survey was to obtain a chest X-ray of every person in the valley 15 years of age and over. Children under age 15 were X-rayed only on specific request and referral from a physician.

To determine the makeup of the population X-rayed, every tenth registration card of all individuals registered for 70-mm. film X-rays

was checked. This sample served as a basis for studying the suspect cases reported through 14″ x 17″ film retakes and the diagnosed cases reported through epidemiological followup. General makeup of the participating survey group with respect to age and sex, by county, is shown in tables 1 and 2, and breakdown of the total valley population by age and sex is shown in table 7.

Statistical Analysis

The 1950 census of the 8 valley counties showed a combined population, age 15 years and over, of 375,815. The total of 237,229 70-mm. films taken during the survey would indicate a coverage, ignoring duplications and nonresidents, of approximately 63 percent of those eligible (table 3).

A total of 7,415 small films were read as showing abnormalities. Of these 4,222 were suspect tuberculosis, 2,846 other chest pathology and 347 suspect cardiovascular disease. Twenty-two of the 7,415 were duplications, which left 7,393 individuals for recall to retake centers (table 3).

Seven hundred seven individuals of the 7,393 recalled did not respond. Small films of these persons were reviewed, and 206 were classified as not sufficiently significant to warrant further followup. One hundred seven, who were visitors to the area or had moved since X-ray, were referred to the health departments of their jurisdictions for followup, and 192 were referred to valley health departments. The remainder were found already under care, or referred to physicians or State institutions, or were deceased (table 4).

A total of 6,822 individuals returned for retakes, including 136 with unsatisfactory or negative 70-mm. films. Of these, 6,560 had confirmatory 14″ x 17″ films taken while 262 received cardiac interview only, with referral to to their physician (table 3).

Out of 6,560 confirmatory 14″ x 17″ films taken, 11 were technically unsatisfactory and were referred for further followup. An additional 2,766 individuals were referred for further study on the basis of X-ray interpretation, 1,264 for tuberculosis and 514 for suspect tuberculosis. The remaining X-ray referrals were 988 for other chest diseases including 89 cardio-

Table 4. Referrals for followup, Willamette Valley chest X-ray survey, 1951

Referrals	Valley total	Benton	Clackamas	Lane	Linn	Marion	Polk	Washington	Yamhill
Individuals referred for followup	[1] 2,777	149	356	733	238	630	202	256	176
Tuberculosis	1,778	107	246	454	158	376	131	168	107
Total reinfection type	1,264	71	147	306	116	286	116	112	92
Minimal	840	50	99	198	81	195	73	71	59
Moderately advanced	348	18	40	86	29	75	35	31	30
Far advanced	39	2	5	7	3	8	6	6	2
Unclassified	37	1	3	15	3	8	2	4	1
Suspect tuberculosis	514	36	99	148	42	90	15	56	15
Cardiovascular	89	5	13	26	7	19	3	7	8
Other chest diseases	899	37	95	252	73	230	66	80	61
Technically unsatisfactory	11	0	2	1	0	5	2	1	0
Individuals not responding	[2] 707	20	100	115	59	133	22	49	35
Already under care for tuberculosis	13	0	4	5	0	4	0	0	0
Referred to physician	87	2	19	24	4	23	5	6	4
Referred to State health departments as suspect tuberculosis (visitor or moved)	107	0	2	5	3	4	1	1	1
Visitor, nontuberculosis, not referred	78	0	0	2	1	1	1	1	0
Deceased	10	0	5	0	0	2	2	1	0
Small film reclassified as not significant	206	7	40	43	24	39	5	22	14
No disposition, referred to health department	192	11	30	36	27	46	8	18	16
Referred to State institutions	14	0	0	0	0	14	0	0	0

[1] Includes 37 persons with residence outside the valley.
[2] Includes 174 persons with residence outside the valley.

Table 5. Followup and final diagnosis and active tuberculosis and neoplasm cases per 1,000 70-mm. films, Willamette Valley chest X-ray survey, 1951

Status and rate	Valley total	Benton	Clackamas	Lane	Linn	Marion	Polk	Washington	Yamhill
	Followup and final diagnosis								
Referred for followup	[1] 2,777	149	356	733	238	630	202	256	176
Followup completed	2,234	131	328	564	206	461	166	231	147
Percent followup completed	80.4	87.9	92.1	76.9	86.6	73.2	82.2	90.2	83.5
Final diagnosis as:									
"Register" tuberculosis [2]	251	10	21	50	35	74	16	20	25
Inactive tuberculosis [3]	875	65	136	195	89	139	84	97	70
Neoplasm	125	6	20	19	13	38	10	12	7
Cardiovascular [4]	26	2	1	12	3	2	2	3	1
Other chest diseases	542	20	52	152	49	129	45	68	27
Negative	415	28	98	136	17	79	9	31	17
	Active tuberculosis and neoplasms								
Number small films taken	237,229	14,608	29,816	60,525	24,446	53,519	13,233	24,126	16,956
Number active tuberculosis cases per 1,000 small films	0.55	0.34	0.60	0.55	0.57	0.47	0.68	0.50	0.88
Number neoplasms per 1,000 small films	.53	.41	.67	.31	.53	.71	.76	.50	.41

[1] Includes 37 persons with residence outside the valley.
[2] Cases requiring public health supervision. Includes (1) active; (2) arrested less than 2 years; (3) activity undetermined.
[3] Inactive or arrested 2 years or more.
[4] Bulk of cardiac suspects (70 mm.) not included.

Table 6. Category of diagnoses after referral to physician, by age and sex, Willamette Valley chest X-ray survey, 1951

Diagnosis	Total	Under 15	15–24	25–34	35–44	45–54	55–64	65+	Unknown
Negative	415	4	20	32	58	89	97	114	1
Male	216	1	10	14	30	47	49	65	0
Female	199	3	10	18	28	42	48	49	1
"Register" tuberculosis [1]	251	0	13	41	43	38	51	65	0
Male	156	0	5	18	29	25	30	49	0
Female	95	0	8	23	14	13	21	16	0
Inactive tuberculosis	875	3	20	81	134	171	210	255	1
Male	447	1	11	33	62	93	115	132	0
Female	428	2	9	48	72	78	95	123	1
Neoplasms	125	1	3	7	12	27	24	49	2
Male	71	0	1	6	5	17	16	24	2
Female	54	1	2	1	7	10	8	25	0
Cardiovascular	26	0	0	0	4	5	5	12	0
Male	16	0	0	0	2	1	5	8	0
Female	10	0	0	0	2	4	0	4	0
Other chest diseases	542	2	24	38	65	88	154	171	0
Male	256	1	11	21	34	39	70	80	0
Female	286	1	13	17	31	49	84	91	0
All diagnoses	2,234	10	80	199	316	418	541	666	4
Male	1,162	3	38	92	162	222	285	358	2
Female	1,072	7	42	107	154	196	256	308	2

[1] Cases requiring public health supervision. Includes: (1) active; (2) arrested less than 2 years; (3) activity undetermined.

Table 7. Population participation,[1] active tuberculosis cases, and neoplasm cases, by age and sex, Willamette Valley chest X-ray survey, 1951

Cases and rates	Total [2]	Under 15	15–24	25–34	35–44	45–54	55–64	65+	Unknown
Total population in survey counties	520, 850	145, 035	77, 089	79, 098	72, 904	57, 657	45, 930	43, 137	----------
Male	266, 019	74, 539	38, 803	39, 919	37, 167	29, 846	23, 747	21, 998	----------
Female	254, 831	70, 496	38, 286	39, 179	35, 737	27, 811	22, 183	21, 139	----------
Number participating in survey	235, 810	6, 580	53, 230	49, 510	47, 040	34, 780	25, 030	18, 300	1, 340
Male	114, 110	3, 090	24, 780	23, 750	22, 630	17, 170	12, 280	9, 680	730
Female	121, 700	3, 490	28, 450	25, 760	24, 410	17, 610	12, 750	8, 620	610
Percent participating	45. 3	4. 5	69. 1	62. 6	64. 5	60. 3	54. 5	42. 4	----------
Male	42. 9	4. 1	63. 9	59. 5	60. 9	57. 5	51. 7	44. 0	----------
Female	47. 8	5. 0	74. 3	65. 7	68. 3	63. 3	57. 5	40. 8	----------
Number of active tuberculosis cases found	131	0	8	29	23	17	24	30	0
Male	84	0	3	13	14	12	16	26	0
Female	47	0	5	16	9	5	8	4	0
Number of active tuberculosis cases per 1,000 participants	. 56	0	. 15	. 59	. 49	. 49	. 96	1. 64	0
Male	. 74	0	. 12	. 55	. 62	. 70	1. 30	2. 69	0
Female	. 39	0	. 18	. 62	. 37	. 28	. 63	. 46	0
Number of neoplasm cases found	125	1	3	7	12	27	24	49	2
Male	71	0	1	6	5	17	16	24	2
Female	54	1	2	1	7	10	8	25	0
Number of neoplasm cases per 1,000 participants	. 53	. 15	. 06	. 14	. 26	. 78	. 96	2. 68	1. 49
Male	. 62	0	. 04	. 25	. 22	. 99	1. 30	2. 48	2. 7
Female	. 44	. 29	. 07	. 04	. 29	. 57	. 63	2. 90	0

[1] These data are based on a 10-percent sample of original report cards. Estimated numbers X-rayed vary slightly from totals shown in tables 3 and 5, which are totals enumerated by the survey units. Discrepancies are mainly due to loss of approximately 850 registration cards in Clackamas County.

[2] Percentages are decreased by inclusion of the under age 15 group, who were X-rayed only on specific request of, and referral from, a physician.

vascular. Reported essentially negative were 1,986 (tables 3 and 4).

Of the 2,777 individuals referred for further study, a total of 2,234, or 80.4 percent, were followed to completion of diagnosis (table 5). The remaining 543 individuals were followed by field visit, mail query, and by contacting the physician named at time of X-ray, but for various reasons, such as moving out of area, noncooperation, and death, final diagnosis was not obtained. Completion of followup to diagnosis varied from 73.2 percent in Marion County to 92.1 percent in Clackamas.

Final diagnosis on the above 2,234 individuals, as supplied by the attending physician, is shown by county in table 5. Diagnosis was accepted only on signed report of the attending physician and no case was tabulated as tuberculosis on the basis of X-ray interpretation or positive sputum findings, or both, without clinical appraisal and report. An arbitrary cutoff date of 2 years postsurvey was adopted, and survey cases reported after this date were not credited to the survey. Only previously unreported active tuberculosis cases were credited to survey discovery.

On these bases there were 131 previously unknown active pulmonary tuberculosis cases reported and 125 neoplasms. One hundred twenty individuals, including 90 with activity undetermined at time of report and 30 arrested or inactive less than 2 years, were also reported and added to the tuberculosis followup register. In addition, 542 individuals were reported for other miscellaneous chest diseases and 26 for cardiovascular disease.

Table 5 shows by county the yield of newly discovered active tuberculosis cases and neoplasms per 1,000 70-mm. films taken. On the basis of 237,229 70-mm. films for the entire val-

ley, 0.55 active tuberculosis cases and 0.53 neoplasms were found for each 1,000 small films. The 899 individuals referred on 70-mm. and 14″ x 17″ films for other chest diseases, and approximately 351 for cardiovascular disease, undoubtedly included many with previously undiagnosed conditions who benefited by further study, but no attempt is made to tabulate or break down for further study these cases reported.

As might be expected, significant differences were revealed for diagnosis of tuberculosis and neoplasms in individuals of various age groups and different sex. Variation was also found in occurrence rates in different counties. Breakdown of physician diagnosis by age and sex is shown in table 6, while table 7 shows the findings of active tuberculosis and neoplasms by 10-year age groups, and the number of cases per 1,000 small films taken of participants. Cursory examination reveals that while the survey participation was poorest in the age group 65 and over the returns per 1,000 70-mm. films taken were highest in this group both in active tuberculosis cases and neoplasms found. This would seem to indicate a need for increased emphasis on the older age groups in future surveys.

Clackamas, Linn, Marion, and Yamhill Counties seemingly had the highest overall tuberculosis case yields. The relatively high rate per 1,000 miniature films may be particularly significant in Marion County in view of the low percentage of completed followup. Similarly,

Table 8. Tuberculosis cases by county and sex, according to stage and activity, Willamette Valley chest X-ray survey, 1951

Stage and activity	Valley total		Benton		Clackamas		Lane		Linn		Marion		Polk		Washington		Yamhill	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Minimal:																		
Active	17	15	0	1	2	4	4	0	3	1	3	2	3	1	0	4	2	2
Activity undetermined	25	16	0	0	0	0	2	1	6	3	15	11	0	0	1	1	1	0
Arrested or inactive less than 2 years	10	4	0	0	1	0	3	1	2	1	0	1	2	0	0	0	2	1
Moderately advanced:																		
Active	56	28	2	2	8	1	18	6	4	5	10	8	4	1	4	2	6	3
Activity undetermined	16	11	3	0	0	1	0	1	2	2	5	4	2	0	3	1	1	2
Arrested or inactive less than 2 years	6	5	0	0	1	0	1	1	0	1	1	2	1	0	0	0	2	1
Far advanced:																		
Active	9	4	0	0	1	1	3	2	1	0	1	1	0	0	2	0	1	0
Activity undetermined	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Arrested or inactive less than 2 years	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Unspecified stage:																		
Active	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Activity undetermined	12	9	1	1	0	0	4	2	3	0	4	4	0	1	0	1	0	0
Arrested or inactive less than 2 years	2	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0
Inactive:																		
Minimal	321	321	27	30	40	36	59	75	45	27	59	45	25	35	42	40	24	33
Moderately advanced	86	61	3	3	15	7	29	19	6	7	15	7	9	10	5	4	4	4
Far advanced	11	6	0	1	3	0	1	0	0	1	3	1	3	0	1	2	0	1
Unspecified	29	40	1	0	15	20	5	7	2	1	3	6	0	2	2	1	1	3

Table 9. Year of last prior chest X-ray according to category of definitive diagnosis, Willamette Valley chest X-ray survey, 1951

Category of definitive diagnosis	Total patients	Within 1 year	1 to 2 years	2 to 3 years	3 to 5 years	5 years or more	Date unknown	No prior chest X-ray	Not stated
Tuberculosis	1, 126	29	104	187	193	269	23	268	53
Neoplasms	125	4	14	15	18	25	1	42	6
Other	568	12	37	89	90	139	6	167	28
Total	1, 819	45	155	291	301	433	30	477	87

the low overall participation in Clackamas County may largely nullify the comparative case-finding results in that county in view of the claim by some that the proportion of positive tuberculosis findings increase as coverage approximates 100 percent of eligibles. Further study of findings by age group and sex by county may prove of value.

The arbitrary 2-year diagnostic followup and report period, adopted to permit as full a completion of diagnostic study and completion of reporting as reasonably possible, doubtless does have a tendency to increase the ratio of moderately and far-advanced cases over minimal. Stage of disease of all survey cases at time of reporting is shown by county in table 8. Of the 131 reported active cases, approximately 24.5 percent were reported as minimal, and 64.1 percent as moderately advanced. Only 13 cases in all, or 9.9 percent, were reported as far advanced. In 1.5 percent the stage of disease was not indicated. These figures compare favorably with available Oregon data on routinely reported pulmonary cases for 1953, which show of 320 such cases only 15.3 percent were minimal, 36.6 percent moderately advanced, and 26.2 percent far advanced. In 21.9 percent, the stage was undetermined.

At the time of registration for miniature chest X-ray, a history was obtained of the length of time since previous chest X-ray. Among the tuberculosis cases diagnosed, almost one-fourth had had no chest X-ray in 5 years, while an equal number had never had a prior chest X-ray. Among neoplasm cases, 20 percent had had no chest X-ray in 5 years, while one-third had never had prior chest X-rays. Exact figures according to diagnosis are shown in table 9. Considering all diagnoses together, almost exactly one-half the cases had no prior X-rays or had none within 5 years.

Conclusion

Results of this survey definitely indicate the value of mass chest X-ray of apparently healthy people. The discovery of slightly more than one previously unknown active case of tuberculosis for every 2,000 participants would alone justify the survey without considering the cases of neoplasm and cardiovascular and other chest diseases revealed as an extra dividend. It is recognized that other procedures such as routine chest X-ray of hospital admissions will reveal higher numbers of cases per 1,000 chest films, but such surveys dealing with ill people are complementary and not a substitute for surveys of the apparently well. Cases discovered before symptoms force medical consultation are found in earlier stages of disease although many suspects screened by routine chest X-ray go a distressingly long time before final definitive diagnosis.

Public Health Awards

By HOMER N. CALVER, B.S.

NEARLY 50 awards are given regularly in the field of public health, most of them annually. They are administered through more than 30 national, State, and local organizations. With few exceptions these awards go to individuals and are presented at the annual meeting of the administering organization.

In addition to the scroll, plaque, medal, certificate, or trophy which the winner receives there is sometimes an honorarium, ranging in value from $50 to $2,500. The presentation ceremony usually includes a résumé of the recipient's career and references to the accomplishments that brought him the award.

An analysis of these public health awards (see table) was undertaken by the Public Health Committee of the Paper Cup and Container Institute when it decided to establish an award in the memory of Dr. Samuel J. Crumbine. The study revealed that there were no national awards for health departments. This was surprising because of the emphasis on teamwork in public health and the fact that the full-time local health unit has long stood as the symbol of the most desirable vehicle for community public health service.

As one reads the statements which outline the basis for selecting winners of the several awards, there is a notable repetition of the nouns: contribution, service, achievement, accomplishment. They are used in nearly all possible combinations with these adjectives: meritorious, outstanding, distinguished, exceptional, signal, significant, distinctive. The Pennsylvania Public Health Association, with a refreshing variation of terminology and criterion, offers an award for "enthusiastic leadership."

The awards place considerable emphasis on accomplishments in the field of research, with a corresponding neglect of recognition of administrative and program accomplishments. This, too, is surprising in a field which is essentially one of applied science.

These and similar observations concerning the existing awards led the Public Health Committee of the Paper Cup and Container Institute to conclude that the Crumbine Award might be useful if it were made to health departments and the winners were judged on evidence of teamwork within that department and with community groups.

The accompanying table gives an analysis of

Mr. Calver, secretary of the Public Health Committee of the Paper Cup and Container Institute, is editor of the Health Officers News Digest. Robert E. Mytinger, assistant to the secretary, made the tabulations.

Samuel J. Crumbine

Dr. Samuel J. Crumbine's distinguished career included service as the first full-time health officer of Kansas and director of the American Child Health Association. Among his pioneer contributions were the crusades he organized against flies and against the common drinking cup and spitting in public places and water pollution. His achievements were, therefore, not only those of an outstanding administrator but those of a leader in the fight for sanitation. Moreover, the impact of his work had been achieved through methods which eventually became an inherent part of what subsequently was called "health education." He died at 91, at which time he was a consultant on the staff of the Paper Cup and Container Institute.

available awards, which should benefit not only the public health worker who may wish to compete but also those persons or groups who may wish to establish new awards. It would be fitting for new awards to be created for achievements in administration, program accomplishment, and communication.

Omitted from the tabulations are the following categories of honors: (*a*) those not primarily intended for workers in the field of public health although from time to time those awards may be given to individuals who are also active in public health; (*b*) those given for length of service or length of membership; (*c*) those given for published papers describing research as distinct from those for the research itself; (*d*) those given to former officers and members for service to the organization; (*e*) election to Delta Omega or to other honorary societies; (*f*) scholarships and fellowships; (*g*) honorary lectureships.

[*Public Health Reports* welcomes supplementary information which may be used in possible future revisions of this tabulation.—ED.]

Public Health Awards

Name, sponsor, and administrator [1]	Type [2]	Eligibility for award	Basis
American Hospital Association Award of Merit. American Hospital Association (S, A).	Medallion and scroll.	Hospital administrators.	Outstanding accomplishments in the hospital field and in improving hospital care.
American Occupational Therapy Association Award of Merit. American Occupational Therapy Association (S, A).	Citation certificate; number not fixed.	Members	Outstanding service to field.
Anderson Service Award. American Association for Health, Physical Education, and Recreation (S, A).	Certificate; no more than 6 per year.	Nonmembers	Outstanding contributions to field; may be general educator or doctor.
Axson-Choppin Award. Louisiana Public Health Association (S, A).	Plaque	Citizen not connected with health department.	Outstanding contributions to health progress in State.
Bell Award. National Association for Mental Health (S, A).	Trophy	Newspapers	American daily newspaper which during the preceding year had made an outstanding contribution in the fight against mental illness.
Biggs Medal. New York State Public Health Association (S, A).	Medal	Public health workers.	Contribution to public health.
Blakeslee Award. American Heart Association (S, A).	$500 each and scroll. Generally 4 given—1 each for newspapers, magazines, books, and radio and television.	Authors, newspaper writers, producers, publishers, and so on.	Creative efforts in any medium of mass communication judged to have contributed most to public understanding of the progress in research and in the prevention, care, and treatment of heart and circulatory diseases.
Borden Awards. The Borden Company (S):			
American Home Economics Association (A).	$1,000 and gold medal.	Members	Fundamental research in the field of nutrition and experimental food, reported in public documents or official journals.
American Institute of Nutrition (A).	do	do	Distinctive research which has emphasized the nutritive significance of the components of milk or of dairy products.
American Veterinary Medical Association (A).	do	do	Outstanding research contributing to dairy cattle disease control.
Bruce Memorial Award. American College of Physicians (S, A).	$250, bronze medal, and travel expenses.	Anyone	Outstanding accomplishments and contributions in the field of preventive medicine.

Footnotes at end of table.

Public Health Awards—Continued

Name, sponsor, and administrator [1]	Type [2]	Eligibility for award	Basis
Crumbine Medal. Kansas Public Health Association (S, A).	Medal	Lay or professional	Outstanding contribution to health of the people in Kansas. May be a native Kansan who has made major contribution while in another State. Regional or national recognition is desirable.
Crumbine Award. Public Health Committee of the Paper Cup and Container Institute (S, A).	1 plaque and medals as merited.	Health unit, health officer and person or persons in unit most directly responsible.	Outstanding achievement in the development of a comprehensive program of environmental sanitation.
Crumbine Award. Public Health Committee of the Paper Cup and Container Institute (S, A).	do	do	Outstanding achievement in the development of a program of eating and drinking sanitation.
Cummings Memorial Award. American Industrial Hygiene Association (S, A).	$100 for paper at banquet and plaque.	Industrial hygienist	Outstanding contributions to the knowledge and practice of the profession of industrial hygiene.
Dana Gold Medal. St. Louis Society for the Blind (S). National Society for the Prevention of Blindness (A).	Medal	Medical and nonmedical public health workers.	(*a*) Long meritorious service for conservation of vision, for prevention and care of diseases dangerous to eyesight, or (*b*) research and instruction in opthalmology and allied subjects, or (*c*) social service for the control of eye diseases.
Florida Association of Sanitarians Scroll. Florida Association of Sanitarians (S, A).	Scroll	Sanitarians	Outstanding accomplishments in the field of sanitation.
Gold Heart Award. American Heart Association (S, A).	Scroll and pin; 1 to physician; 1 to layman.	Physician, business, or public health leader.	Outstanding contributions to the advancement of cardiovascular medicine or the heart program
Gulick Award. American Association for Health, Physical Education, and Recreation (S, A).	Medal	Members or nonmembers.	Outstanding contributions to field.
International Association of Milk and Food Sanitarians Award. Five detergent manufacturers (S). International Association of Milk and Food Sanitarians (A).	$1,000 and citation certificate.	Sanitarian attached to local health department.	Outstanding service and meritorious accomplishment in field of sanitation.
Johnson Annual Award. Missouri Public Health Association (S, A).	Scroll	Professional public health worker or layman.	Any person who has made an outstanding contribution to public health in Missouri.
Kimble Award. The Kimble Glass Company (S). Conference of State and Provincial Public Health Laboratory Directors (A).	$500 and citation certificate.	Lab personnel	Contributing outstandingly to developing a new and better method in the field of public health.
Lasker Award. Albert and Mary Lasker Foundation (S). American Heart Association (A).	$1,000, scroll, and statuette.	Physician or scientist.	Outstanding scientific contributions in the field of cardiovascular research.
Lasker Award. Albert and Mary Lasker Foundation (S). American Public Health Association (A).	$1,000 and a statuette. Occasionally a special individual award of $2,500, scroll, and statuette to groups; 4–10 per year.	All categories of public health workers. Individuals or groups—official or voluntary.	Outstanding achievements in either research or in administrative application of research in the control of diseases that are recognized as major causes of death.

Footnotes at end of table.

Public Health Awards—Continued

Name, sponsor, and administrator[1]	Type[2]	Eligibility for award	Basis
Lasker Award. Albert and Mary Lasker Foundation (S). International Society for the Welfare of Cripples (A).	$1,000 and statuette triennially; number not fixed.	Lay or professional	Achievement in the development of services for the physically disabled.
Massachusetts Association of Sanitarians Scroll. Massachusetts Association of Sanitarians (S, A).	Scroll	Sanitarians	Massachusetts sanitarian who in past year did most to enhance the status of the association and public health work.
National Society for Medical Research Citation. National Society for Medical Research (S, A).	Citation certificate; 1–3 per year.	Unrestricted	Contribution to public understanding of medical science.
New York State Public Health Association Health Education Information Citation. New York State Public Health Association (S, A).	Citation certificate; 3–4 per year.	Newspaper, radio or television station.	Contribution to better understanding of health matters.
North Carolina Public Health Association Award of Merit. North Carolina Public Health Association (S, A).	Citation certificate	Group of members associated in some accomplishment.	Outstanding contributions or activities during past year for a local health department or group.
Nutting Award. National League for Nursing (S, A).	Medal and scroll; 1 every other year.	Public health workers—official, nonofficial.	Outstanding contribution to community welfare through nursing education, nursing service, or through some other areas of public health.
Pan American Gold Medal. National Society for the Prevention of Blindness (S, A).	Medal; 1 every 4 years.	Medical and nonmedical public health workers.	Significant contribution to prevention of blindness.
Pennsylvania Public Health Association Award of Merit. Pennsylvania Public Health Association (S, A).	Citation certificate	All public health workers.	Distinguished service and outstanding contributions to the advancement of public health.
Pennsylvania Public Health Association Honorary Membership. Pennsylvania Public Health Association (S, A).	Scroll; 2 per year	do	Enthusiastic leadership in public health work.
Pickett-Webb Memorial Award. Utah Association of Sanitarians (S, A).	$50 and scroll	Sanitarian	Outstanding achievement in field in the State of Utah.
Prentiss Award. Cleveland Health Museum (S, A).	Citation certificate	Health educator	Outstanding achievement in health education field.
Public Health Association of New York City Award of Merit. Public Health Association of New York City (S, A).	Certificate in each category.	All public health workers.	Meritorious service to public health in fields of medicine, dentistry, nutrition, nursing, laboratory service, statistics, administration, social work, health education, environmental sanitation.
Public Health Association of New York City Outstanding Service Award. Public Health Association of New York City (S, A).	Plaque	do	Outstanding service to public health in New York City.
Rankin Award. North Carolina Public Health Association (S, A).	Trophy	Members	Outstanding contributions to public health in North Carolina over period of several years.
Reynolds Award. North Carolina Public Health Association (S, A).	do	do	Outstanding contributions to public health in North Carolina, meritorious service above and beyond the call of duty.

Footnotes at end of table.

Public Health Awards—Continued

Name, sponsor, and administrator[1]	Type[2]	Eligibility for award	Basis
Ross Medal. National Tuberculosis Association (S, A).	Medal	Persons other than medical practitioners or medical scientists.	Outstanding and distinguished contribution to tuberculosis control in some field other than the medical sciences.
Sabin Award. Colorado Public Health Association (S, A).	Citation certificate	Usually lay	For outstanding contribution to public health outside of professional responsibilities.
Sedgwick Award. American Public Health Association (S, A).	Medal	Individual public health workers.	Distinguished service in public health.
Shattuck Award. Massachusetts Public Health Association (S, A).	do	Unrestricted	Outstanding contribution to public health in New England.
Sippy Memorial Award. Western Branch, American Public Health Association (S, A).	Plaque	Public health personnel.	Outstanding contributions to the promotion of public health in the association's district in which the annual meeting is held.
Trudeau Medal. National Tuberculosis Association (S, A).	Medal	Medical and nonmedical.	Most meritorious contribution on the cause, prevention, or treatment of tuberculosis.
Weinstein Award. United Cerebral Palsy Association (S, A).	$1,000 and plaque	Scientists in scientific research.	Outstanding recent scientific research in field of cerebral palsy.
White Memorial Award. Louisiana Public Health Association (S, A).	Plaque	Member of the State department of health.	Meritorious contribution to health work in the State over prolonged period.

[1] S—Sponsor; A—Administrator. [2] Except as noted, 1 award is given each year.

Chlortetracycline as a Preservative

The antibiotic chlortetracycline may now be used as a preservative for uncooked poultry. First marketed as aureomycin, the chemical will be sold under the trade name Acronize chlortetracycline. The Food and Drug Administration ruling, announced November 30, 1955, marks the first time an antibiotic has been permitted in food processing.

According to submitted data, chlortetracycline, added to the water in which the poultry is chilled after dressing, retards development of spoilage organisms and thereby prolongs the freshness of the poultry. Effectiveness of the process depends upon its application to clean, freshly killed birds.

FDA has set a tolerance of 7 p.p.m. for residue of chlortetracycline remaining in any portion of the uncooked bird. FDA's decision was based on evidence that cooking destroys this amount of chlortetracycline so that none is left when the poultry is served.

Permission was granted in accordance with provisions of the Miller amendment to the Federal Food, Drug, and Cosmetic Act, which authorizes the fixing of tolerances for pesticide residues on raw agricultural products, provided there is suitable evidence of usefulness and of the safety of the permitted residues. With this exception, FDA has not changed its basic position that the law bans the use of antibiotics in human food.

Public Health Research in Chronic Disease

By JOHN E. DUNN, Jr., M.D.

THE changing nature of the health problems that burden our society is becoming increasingly apparent. The severe outbreaks and epidemics of the infectious and communicable diseases are giving way to the endemicity of chronic disease.

"Chronic disease" as a generic term usually conjures up such entities and groups of diseases as heart disease, cancer, mental diseases, and diabetes. Actually, the connotation is broader than the mere disease label. There is the added implication of insidious progression, slow and incomplete recovery, disability, necessity for adaptation on the part of the affected individual, and the host of services—medical, nursing, social, economic, housekeeping, rehabilitation—involved in the struggle between an individual and a chronic disease from which he is trying to recover or with which he is learning to live. A definition adopted by the Conference on the Preventive Aspects of Chronic Disease in 1951 (*1*) states that "chronic disease comprises all impairments or deviations from normal which have one or more of the following characteristics: (*a*) are permanent; (*b*) leave residual disability; (*c*) are caused by nonreversible pathological alteration; (*d*) require special training of the patient for rehabilitation; and (*e*) may be expected to require a long period of supervision, observation, or care." Although one might wish to quibble with some of the details of this definition, it paints the picture of chronic disease essentially as seen through the eyes of the victim. The summation of such victims in a community delineates the problem of public health.

A definition of chronic disease has been considered; it would seem unnecessary to define research. Here too, however, there are differences of opinion as to what should be included in the term. Such modifying adjectives as "applied," "field," "clinical," "epidemiological," and "administrative" are used to distinguish the fuzzy limits of what can be encompassed by so jealously guarded a term as research. If we consider research as a quest for knowledge and view the chronic disease problem from the vantage point of public health responsibility, we are immediately impressed with the fragmentary nature of knowledge and the rather general ignorance of the whole spectrum of chronic diseases and their chronology from etiology to recovery, symbiotic stabilization, or death. In this discussion research in chronic disease is considered in its broadest sense and from the standpoint of public health responsibility. Since I am working in the can-

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cer field, I will draw on that subject for illustrative purposes.

Areas of Research

Chronic diseases and conditions are problems of public health for one or more of the following reasons: (*a*) their relative importance as causes of death; (*b*) their responsibility for prolonged disability, during which time the affected individual is not self-sufficient, with all that this implies; and (*c*) the ability of the community, through organized effort, to meet many of the problems that are difficult or insoluble for the individual.

Public health has a need of knowledge of the whole chronology of chronic disease, from the characteristics, habits, and surroundings of individuals that give them a special proclivity for a certain disease or diseases, as, for example, current interest in obesity and cigarette smoking, to the requirements of the individual with stabilized disease which will return him to an active, useful life The chronology of chronic disease for the purpose of this discussion can be conveniently, although somewhat arbitrarily, divided into the following stages: (*a*) the predisease period, during which the unknown and suspected etiological factors are operating; (*b*) the incipient stage, when the disease is recognizable by some clinical or laboratory means but is not yet symptomatic; (*c*) the full-blown symptomatic stage; (*d*) stabilization of the disease process and maximal recovery; and (*e*) restoration of the patient to useful life. The first two stages are the most appealing to preventive medicine and public health and the actual or potential means for attacking chronic diseases at these stages have been designated primary and secondary prevention, respectively (*1*). The third stage, of course, is the period for skilled medical management. The fourth and fifth stages are periods when the individual is in greatest need of assistance and services from various community resources, that may or may not exist, in his effort to become an active useful person again.

Etiology

It is difficult to deal with a disease empirically. It is understandable, then, why primary interest should center on laboratory and clinical research to elucidate the etiological and pathogenic mechanisms of the chronic diseases. We have only to look at the tremendous increase in the amount of money that has been made available for medical research in recent years, much of which is directed toward study of the etiology and pathogenics of the chronic diseases, to realize the urgency felt for knowledge to combat the ever-increasing burden of disability and death for which these diseases are responsible. It is estimated that in 1952 the Nation spent an estimated $180 million for medical research; 42 percent came from government sources; 33 percent, from industry; 14 percent, from private philanthropy; and 11 percent, from hospitals and medical schools. The total amount is a tenfold increase over the expenditures for medical research of a decade before (*2*). In 1952, the Public Health Service administered $18 million of grant funds to support medical research in addition to the funds for its own growing research program. The recent opening of the Clinical Center of the National Institutes of Health is a big step forward in furthering the research effort toward solving the problem of chronic disease development.

Almost every scientific discipline of the biological and natural sciences is represented somewhere on the research team attacking the array of morbid processes included in the chronic diseases; and research interest ranges from a study of the simplest biological systems to the response of whole organisms to experimental conditions. The volume of research findings is tremendous and is not easily synthesized into a total picture. However, there can be little doubt that the picture can be completed and the etiology and pathogenesis of the chronic diseases understood. From the public health vantage point, these research developments are to be viewed with keen interest and hope that better means of anticipating, diagnosing, and treating the chronic diseases will evolve.

Despite the momentum that chronic disease research is gathering, there is still the feeling that insufficient emphasis is being directed toward certain approaches to the study of the occurrence of chronic disease (*3*, *4*). This stems partly from a lack of personnel with disciplinary training oriented to the chronic

disease problem and partly from the lack of research equipment and techniques having the precision and accuracy of those available to the laboratory investigator. I am referring to the epidemiological study of chronic diseases. Man is a complex animal who has evolved a complex and largely artificial social structure within which to live. Not all economic and technological progress is necessarily good for him in a biological sense. He eats too much, smokes too much, drinks too much, and lives under too much tension. Evidence is accumulating to indicate that these, and other factors much less obvious, play a part in the occurrence of chronic disease. Epidemiologically speaking, then, the soil should not be neglected in preoccupation with the seed. Epidemiology is primarily a tool of public health.

Cancer has perhaps received more attention, meager and superficial as it has been, than any of the other chronic diseases regarding the characteristics and attributes of people that are related to the occurrence of the disease. Most of this comes under the classification of descriptive epidemiology and has perhaps served to raise more questions than it has answered. Much of what has been learned in cancer epidemiology, or endemiology as some would prefer to call it, has had to come from existing data, such as mortality records, or from short-term retrospective studies that could be handled with limited finances. Nevertheless, some rather clear-cut and specific findings have come out of such investigations, such as bladder cancer as a result of beta-naphthylamine exposure in the aniline dye industry, chromate cancer in the chromate industry, the direct relationship of the amount of solar radiation and the frequency of skin cancer, the relative immunity of Jewish women to cervical cancer, and, more recently, the association of cigarette smoking and lung cancer. Other established associations are in need of further explanation. Cancer of certain sites has been shown to exhibit a socioeconomic gradient. For example, cancer of the upper gastrointestinal tract and stomach and cancer of the cervix show an increasing incidence as economic status decreases. A gradient in the opposite direction is shown by cancer of the breast and ovary. These findings originated from studies carried on in England and, later, in Denmark. Recently, studies to determine the existence of such gradients in this country have been undertaken, one of which is nearing completion for San Francisco. The findings of these several studies differ in certain details but confirm the fact that cancer of certain sites does have socioeconomic gradients.

Isolated studies concerning cancer of the cervix have shown association of this disease with a multiplicity of variables, including the fact of marriage, age at marriage, childbearing, economic status, stability of marriage, syphilis, circumcision of spouse, and race. Certainly, there is need and opportunity for unraveling this multiplicity of variables, many of which are correlated with each other.

Recently, there has been a trend toward use of the more expensive and time-consuming, but much more satisfactory, prospective type of epidemiological approach. Perhaps this indicates a more general realization of the contribution that the methods of epidemiological study can make to the problems of the chronic diseases. The findings relative to cigarette smoking and lung cancer have been confirmed by such studies in both this country and England (*5*, *6*). A byproduct of considerable importance from both of these studies was the finding that cigarette smoking is also associated with coronary heart disease. A finding such as this could not, of course, come from a retrospective study of lung cancer patients. A study is now under way in California in which the lung cancer risk of certain occupations is being determined. A previous study of the case-control type indicated that certain occupations carried an increased risk of lung cancer. At the present time, populations of workers engaged in these suspect occupations are being assembled, and their lung cancer experience will be determined over the next several years by checking all cancer deaths among males occurring in the State against these assembled populations.

It was determined that populations of 5,000 to 10,000 individuals would be necessary in order to have a reasonable expectancy of lung cancer mortality during the study period. Data on such large numbers would be difficult to collect from industrial establishments, and mailed

questionnaires became of necessity the method for collecting data. Union organizations seemed to offer the best means of gaining access to the occupational groups to be studied. The union organizations have proved to be very cooperative and the percentage of mailed questionnaires completed and returned has ranged between 85 and 90 percent, a most gratifying response. It is expected that the more than 25,000 workers that have entered the study will be increased three- or fourfold before the study populations are closed.

A few years ago a long-term study of heart disease was undertaken in Framingham, Mass., in which some 5,000 individuals were examined. These individuals will be followed over the next several years to determine the factors associated with the occurrence of heart disease. A study of coronary heart disease among London double-deck bus operators showed that conductors had fewer and milder cases of the disease than did drivers (*7*). It was hypothesized that the greater physical activity demanded of conductors in their work might be responsible for this finding. This explanation was supported by similar differences found for physically active and sedentary workers among postal workers and civil servants.

From these illustrations, it should be clear that the epidemiological method can make significant and worthwhile contributions to the understanding of the occurrence of chronic disease. Perhaps the time has come for public health workers to take a more active part in contributing what can be learned from population studies to these problems that are destined to absorb most of our interest and efforts in the near future.

Incipient Stage and Case Finding

It is generally agreed that diseases are more effectively treated if they are recognized in their early stages. This is particularly true for the chronic diseases where progressive and more or less permanent damage is a prominent feature of the pathological processes. In cancer control, the whole program is based on the concept of early recognition and treatment since success or failure is clearly centered on the time when metastasis occurs.

The problems connected with recognition of the incipient stage of chronic disease are twofold: What techniques do we have for their recognition? How do we use them effectively? These two questions are intimately related to each other. A procedure that is technically difficult, time consuming, and expensive is hardly adaptable to examining the general population for unsuspected disease, for example, conventional gastrointestinal series for X-ray examination of the alimentary canal for possible cancer. On the other hand, procedures that are technically suitable for general application but lack sensitivity, specificity, or both will fail from lack of efficiency. An example would be a cancer test based on quantitative changes in the normal serum proteins that occur with this disease, or these diseases, as some prefer.

Dissatisfaction with the number of cases of symptomatic tuberculosis that were coming to diagnosis in the advanced stages led to technological development of miniature X-ray films and successful mass application of the new technique to screening the general population for cases of minimal, asymptomatic tuberculosis. Similar applications have been made of syphilis serology. Cancer detection centers were an outgrowth of this concept. It was natural to extend the concept to multiphasic screening, that is, combining screening procedures to look for a number of diseases simultaneously. So far, attempts to apply this method of identifying incipient and asymptomatic diseases have been sporadic and isolated. Reactions to these attempts have varied. They have been condemned as poor medicine and bad public health (*8*). However, multiple screening is considered to have a place if it can be meshed with the normal flow of patients through medical channels, such as physicians' offices, outpatient departments, hospitals, and industrial medical examinations (*9*).

The basic question, however, seems to me to be whether screening procedures can be the means for bringing the diseases in question under medical management in an incipient or asymptomatic stage rather than in the symptomatic stage when diagnosis is usually made. This implies two things: (*a*) making the procedures available to the general population, or to those segments at major risk from the diseases being sought, as a direct service and not

as a tie-in or bonus feature of some other medical service; and (*b*) screening the population at risk periodically, the frequency to be determined from knowledge of the usual period between the time the screening procedure can first indicate presence of the disease and the time the disease will become manifest.

One important question is, How frequently should a screening procedure be repeated? Initial multiphasic screening of a population largely deals with prevalence of undiagnosed disease. Prevalence is the product of incidence times duration. If one disease has one-fifth the incidence of a second disease in a given population, but the former existed 5 years on the average asymptomatically and the latter, 1 year, the findings in terms of numbers of cases of the two diseases in an initial screening will be the same. However, annual repetition of the screening would produce only one-fifth the number of new cases of the first disease, whereas the second disease would continue to be found in the same numbers. Perhaps repetitive screening for the first disease could effectively and economically be done on a 3- to 5-year cycle. The second disease is committed to annual screening.

One means of evaluating the accomplishments of multiphasic screening would be to compare the course of the cases of a disease so identified with the course of the same disease when first recognized symptomatically. Here we may be misled. Many diseases show a range of rates of progression. The slower-developing and more benign forms of the disease accumulate disproportionately among the undiagnosed, asymptomatic, cases of prevalent disease. Under these circumstances the prognosis for the prevalent cases as a group is more favorable than the prognosis for the incident cases.

Cancer is a disease for which more is at stake in earlier diagnosis perhaps than in any other of the so-called chronic diseases. Among the diseases usually grouped in the chronic disease category, symptomatic cancer is one of the more acute. It is primarily a killer, having the dubious distinction of ranking second in this capacity. Cancer is not found among the chronic diseases listed as responsible for the greatest amount of disability, either in terms of individual cases or collectively for all cases of specific diseases.

Since clinically recognizable cancer, that is, gross tumors that are obvious to direct or X-ray visualization, is such an acute disease, we have a narrow margin of time within which to accomplish asymptomatic diagnosis as a substitute for symptomatic diagnosis. Furthermore, we are forced to search for individual tumor masses at all the sites where they frequently occur because there is no established general pathophysiological change yet discovered associated with the development of cancer that is qualitatively or quantitatively sufficiently unique to serve as a general test procedure.

The cure rate for lung cancer, which has increased so remarkably in recent decades, is negligible when the disease has become symptomatic. Lung tumor masses can be identified in chest X-ray films before symptoms occur. Is this an effective and practical screening procedure for cancer of the lung? The lung cancer results of the Los Angeles mass X-ray survey suggest that X-ray screening can identify cases somewhere in the range of 9 months to a year prior to symptomatic diagnosis. Is this enough earlier to influence prognosis? There is some evidence from the Los Angeles data that it is (*10*), although the improvement still leaves much to be desired. Is the amount of improvement in prognosis real or are the results biased by an undue proportion of slower-growing tumors that can be expected among prevalent cases, as commented on earlier? Other sources of bias are likely in a survey of this type, and the results therefore cannot be regarded as definite. If it is felt that periodic X-ray chest examinations at 6-month intervals has real promise as a means of bettering the prognosis of lung cancer, it is worth a thorough, properly designed study of repetitive examinations in the same population.

The best example of a more hopeful aspect of discovering asymptomatic cancer is the use of exfoliative cytology for cancer of the cervix uteri. Contrary to what was said earlier regarding clinically recognizable cancer (visible gross lesions), the study of cervical cancer with cytology, whereby microscopic lesions without gross abnormality can be identified, suggests that cancer may be a very chronic disease, with the clinical stage as usually recognized being the explosive and lethal phase. The evidence

indicates that there is a preinvasive stage that lasts for several years. Periodic searching for evidence of this lesion, which would seem to be almost certainly curable, may be successfully accomplished at 2-, 3-, or 4-year intervals. A study now in progress in Memphis, Tenn. (*11*), is using exfoliative cytology to determine whether cervical cancer can be made a relatively nonlethal disease when the general population of females is periodically screened by this procedure. Unfortunately, the cytological method is not well adapted to screening for other sites of cancer because of the technical difficulties of obtaining specimens.

The more important questions relative to the substitution of asymptomatic diagnosis for symptomatic diagnosis of the chronic diseases are:

1. What procedures do we have that are technically suitable for mass application?
2. How efficient are these procedures in terms of sensitivity and specificity when used in the asymptomatic general population?
3. What is the pattern of the specific diseases that are being sought in terms of incidence, prevalence, age, and sex selection, and so on?
4. How much earlier, on the average, can the screening procedure pick up the specific disease than it is usually diagnosed as a result of symptoms?
5. As a corollary to this, what is the cyclic frequency for most practical and efficient use of the screening procedure?
6. What is the advantage in prognosis for cases of the disease identified by the screening procedure as compared to those progressing to symptomatic diagnosis?

If intelligent and efficient use is to be made of the concept of multiple screening, such questions as these must be answered no matter how the method is to be applied. If the idea is to be effective in improving the total chronic disease picture, it must be promoted in some organized plan in making it continuously available for any population group. Public health has traditionally taken the leadership in case-finding methods and has most to gain from answering questions such as those proposed. This knowledge is needed if we expect to do more than enumerate for demonstration purposes the number of unattended and undiagnosed diseases and defects that are prevalent in any population in which symptoms are the usual basis for seeking medical attention.

Symptomatic Clinical Disease

The symptomatic clinical stage is the stage of disease for skilled medical management. And the emphasis here is on treatment. The therapeutic advances made and being made are spectacular and become matters of public knowledge almost as rapidly as they appear. The antibiotics have become so well established and are available in such variety to meet almost every special purpose for combating infectious agents, that we accept them as part of our medical heritage. The sulfa drugs, which were the marvel of their day, have already passed into that heritage. Current developments in the manipulation of hormones to influence the course of certain chronic diseases, using the concept of metabolic antagonists in cancer chemotherapy, more effective antihypertensive drugs, and so on, are examples of important progress in therapy for the chronic diseases.

Much of the fundamental research that is being so extensively carried on is directed to an understanding of the basic chemical processes of metabolism in the normal state, in disease, and under the influence of therapeutic agents. Interest includes the cellular components identified with metabolic functions; hormonal effects on cellular metabolism and tissue function; the in vivo fate of therapeutic agents in terms of chemical alteration of the agent, specific action in chemical and functional terms, storage, and excretion; and the chemical nature and physical-chemical state of nutritional elements during blood transport, in tissue fluids, and body storage. The development and perfection of research tools such as radioactive isotopes, electron and phase microscopy, electrophoresis, paper chromatography, and high-speed centrifugation have done much to make this detailed and exacting research possible. Many of the advances in specific means of controlling infection, in understanding of the physiological economy of the body, and in improved anesthesia have made possible the extension of surgical procedures in the cardiovascular, cancer, and other fields.

Out of this extensive medical and biological

research is certain to come an understanding of the detailed mechanism of many of the chronic diseases and, from this understanding, the development of many specific and potent therapeutic agents will follow.

This is a phase of chronic disease research which is not directly related to public health responsibility. Interest has been extended to an evaluation of the efficacy of therapy, such as the use of tumor registries in the cancer field. Therapeutic advances can have considerable effect on the community load of the disabled and incapacitated chronically ill which is a direct interest and responsibility of public health.

The Chronically Ill Population

The philosophy of chronic disease control is to prevent and to mitigate the burden of chronic disease that is now prematurely disabling and incapacitating large numbers of our population. It has been estimated that 4,000,000 persons in the United States are continually victimized by these conditions, three-fourths of them under 65 years of age (*12*). Even with postponement of death through control of disease there will always be a need for community services for those reaching the incapacity of old age and terminal illness (*13*).

Public Health Responsibility

How can public health assay its responsibilities for the chronic diseases without defining the problem in terms of numerical size; relative importance of the various diseases and injuries in terms of incidence and prevalence; nature of the incapacities; type of care being given, by whom, and in what degree of adequacy; unmet needs and who can best provide them; availability of community services and facilities; possibilities for rehabilitation and the availability of this service; and a host of other questions that require answering as the chronic disease problem is dissected and analyzed? A number of morbidity studies are going on now—in New Jersey, Baltimore, and the State of California—to answer many of these questions. In other studies, such as that of the Community Studies, Inc., of Kansas City, Mo., the possibilities and cost of rehabilitating the handicapped and chronically ill are being determined. The generalizations that can be drawn from these studies will be helpful in gaining insight and in providing guidelines for understanding and planning programs to aid and rehabilitate the chronically ill. Each community, however, will have to examine its own problem, do the best it can with what it has, and attempt to discover and rectify its weaknesses. Such community introspection perhaps cannot be graced with the designation of research, but here is where the problem and the solution lie for the care and rehabilitation of our chronically ill.

Summary and Conclusions

1. The chronology of chronic disease is considered from the standpoint of public health interest and responsibility.

2. There has been greatly increased financial support for research directed toward the chronic diseases in recent years, with major emphasis on laboratory and clinical research.

3. The epidemiological method, primarily a tool of public health, has been relatively neglected as a research approach to studying the chronic diseases.

4. Case-finding methods have been inadequately evaluated. A number of questions are posed that must be answered before these methods can be used intelligently and with predictable results.

5. Laboratory and clinical research will eventually elucidate the mechanisms of many of the chronic diseases. Some of these findings will be found adaptable for practical application as preventive measures. These findings should also be scrutinized for adaptation as more discriminatory case finding methods.

6. Advances in therapeutic management give promise of better control of the chronic diseases from the standpoint of stopping or delaying progression before disability and incapacity result.

7. As of now, however, there is a sizable and growing burden of chronic illness and disability among our people which will always be with us in some degree. Public health has the responsibility of studying the problem and contributing its skills to the prevention and control of these diseases, and the support and rehabilitation of those affected.

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technical publications

Education for the Professions

Office of Education Publication. By Lloyd E. Blauch. 1955. 317 pages. Paper, $1.75; buckram, $2.75.

This detailed and extensive sourcebook on education for the leading professions in the United States describes these professions and reports on their development and current status of education. It indicates some of the major problems in professional education, lists schools offering professional curriculums, and presents additional reference information.

Twelve chapters are devoted to the health professions: chiropody, dentistry, hospital administration, medicine, nursing, occupational therapy, optometry, osteopathy, pharmacy, physical therapy, public health, and veterinary medicine. Other fields include accountancy, agriculture, architecture, business administration, engineering, forestry, home economics, journalism, law, library service, music, public administration, social work, teaching, and theology. There are also chapters covering the education of officers in the Army, Navy, Marine Corps, Air Force, Coast Guard, and Merchant Marine.

Outpatient Psychiatric Clinics, 1954

Public Health Service Publication No. 428. 1955. 44 pages. 35 cents.

The first in a series of publications compiled in connection with the new national mental health clinic statistics program, this listing is intended to serve as an interim reference on existing clinics. It is for the use of professional personnel in community agencies throughout the country.

Name and address of each facility meeting a uniform definition of an outpatient psychiatric clinic are listed by State and location. Appendix A gives headquarters of clinic outlets by State and appendix B, agencies designated as State and Territorial mental health authorities.

This section carries announcements of all new Public Health Service publications and of selected new publications on health topics prepared by other Federal Government agencies.

Publications for which prices are quoted are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Orders should be accompanied by cash, check, or money order and should fully identify the publication. Public Health Service publications which do not carry price quotations, as well as single sample copies of those for which prices are shown, can be obtained without charge from the Public Inquiries Branch, Public Health Service, Washington 25, D. C.

The Public Health Service does not supply publications issued by other agencies.

As More People Live Longer

The eighth annual conference on aging, held during the week of June 27, 1955, at the University of Michigan, Ann Arbor, had an official registration of 804. Representatives of 30 States, the District of Columbia, 3 Canadian Provinces, England, and Sweden attended the general sessions and the various workshops.

Sponsors of the conference were the University; the Department of Health, Education, and Welfare; the Department of Labor; the Civil Service Commission; the Housing and Home Finance Agency; the Council of State Governments; United Auto Workers, Congress of Industrial Organizations; Michigan State Medical Society; and the Michigan State Departments of Employment Security, Agriculture, Health, Public Instruction, Mental Health, and Social Welfare.

The chairman of the conference, Dr. Wilma Donahue, who is chairman of the division of gerontology, Institute for Human Adjustment, University of Michigan, reports that one outgrowth of the conference was the formulation of emerging concepts by which the problems associated with aging might be approached. These observations and principles are presented below in the form of a list of tentative conclusions reported by the conference research seminar.

- The proportion of the people in our society who are old is probably going to remain at about the present level to the end of this century. The number of older persons will increase along with the numbers in all other age groups.
- As with other segments of the population, older people can expect more of the better things of life, more leisure and time for creative pursuits as our national productive capacity expands in line with the extension of automation.
- As a result of our added years, all of us will spend more years in the work force, but these years will constitute a smaller proportion of our lives. There will be further decline in work force participation after age 65.
- There is no immediate prospect of a dramatic rise in the total length of life. There will not be a great increase in the life span, but, as a result of medical progress, more of us will live into the older years.
- By employing the emerging concept of treatment of the whole person as opposed to a focus on a particular disease entity, we are achieving spectacular results in restoring the individual to self-function and to a useful place in society. Moreover, treatment of the total person through utilization of the team approach, and the coordinated services of the community can reduce the period of hospitalization from one-third to one-half.
- It is increasingly recognized that the problems of the later years have their onset in the middle years. Therefore, there is need for increased focus on prevention and planning in the fields of health, income maintenance, use of leisure time, education, and living arrangements.
- We may expect continuing pressure on the part of older workers to remain in the labor force until it is possible to guarantee income security and other meaningful roles.
- The need for income maintenance will continue to be a primary concern, and, if present trends continue, we might expect this income to be derived from deferred earnings in the form of social security, private pensions and related benefits, and to a limited extent from personal savings. Also, the provision of more services, such as adult education, recreation, and preventive health services by the community, will contribute to the improvement of the economic status of older people.
- The kinship and household pattern of three-generation families has all but given way to the separate family unit composed of man and wife or of man, wife, and immature children. To a very large extent, the two generations of grandparents and parents are mutually independent and prefer to follow their peer group relationships.
- It might be expected that increasingly inter-

generational relationships will become voluntary in nature as opposed to socially defined, legal, or moral obligations. These relationships will instead be based on affection, congeniality, and mutual interests.

• There is much evidence that leisure will occupy a greater proportion of our lives. This has clear implications for community provision of additional facilities and services for leisure-time pursuits for all generations.

• There exists in many communities a need for the coordination of medical and social services to reduce the problems of institutional medical care and the costs of such care of the old.

• Older persons can do much toward minimizing their own personal adjustment problems by contributing their services where they reside in cooperation and in participation with all other age groups in helping to meet the community needs.

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A brief summary of the conference appears in the September 1955 issue of Geriatrics. Some of the other materials presented at the conference will be published by the University of Michigan Press during the spring of 1956 in a book entitled "Aging's New Frontiers."

Federal Surplus Property

Federal surplus property costing $56,667,227 was distributed to States for public health and educational purposes during July, August, and September, 1955, by the Department of Health, Education, and Welfare.

Under the Federal Property and Administrative Services Act of 1949, the Department channels surplus property to State and local government agencies and to nonprofit institutions, which are exempt from Federal taxes, in the fields of public health and education.

Property transferred includes school and hospital building sites, buildings suitable for students or faculty, motor vehicles, furniture, tools, laboratory equipment, and school and office supplies. Most of the surplus property comes from the Department of Defense.

Disposition of Federal personal and real surplus property (acquisition cost), July 1–Sept. 30, 1955

State	Personal property	Real property	Total	State	Personal property	Real property	Total
Totals	$54,133,736	$2,533,491	$56,667,227	New Hampshire	209, 710		209, 710
				New Jersey	1, 179, 953		1, 179, 953
Alabama	1, 174, 892	25, 358	1, 200, 250	New Mexico	232, 577	139, 077	371, 654
Arizona	32, 329		32, 329	New York	3, 506, 972		3, 506, 972
Arkansas	449, 307	98, 100	547, 407	North Carolina	1, 249, 094		1, 249, 094
California	5, 493, 933	725, 565	6, 219, 498	North Dakota	103, 390		103, 390
Colorado	1, 017, 369		1, 017, 369	Ohio	1, 721, 176	20, 416	1, 741, 592
Connecticut	962, 840		962, 840	Oklahoma	858, 730	65, 960	924, 690
Delaware	318, 362		318, 362	Oregon	1, 106, 460		1, 106, 460
Florida	1, 753, 490	7, 620	1, 761, 110	Pennsylvania	3, 301, 563		3, 301, 563
Georgia	844, 647		844, 647	Rhode Island	431, 698		431, 698
Idaho				South Carolina	1, 235, 899		1, 235, 899
Illinois	1, 783, 044	42, 608	1, 825, 652	South Dakota	315, 917		315, 917
Indiana	793, 322		793, 322	Tennessee	1, 266, 752	404, 165	1, 670, 917
Iowa	815, 802		815, 802	Texas	2, 388, 019	383, 696	2, 771, 715
Kansas	832, 691		832, 691	Utah	954, 558		954, 558
Kentucky	1, 049, 507	260, 611	1, 310, 118	Vermont	225, 509		225, 509
Louisiana	623, 519	1, 503	625, 022	Virginia	976, 827	5, 000	981, 827
Maine	367, 103		367, 103	Washington	1, 035, 051	133, 000	1, 168, 051
Maryland	1, 214, 185		1, 214, 185	West Virginia	570, 831		570, 831
Massachusetts	2, 558, 355	3, 500	2, 561, 855	Wisconsin	1, 189, 517		1, 189, 517
Michigan	1, 173, 749	32, 921	1, 206, 670	Wyoming	88, 101		88, 101
Minnesota	1, 244, 513		1, 244, 513	Alaska		18, 091	18, 091
Mississippi	1, 013, 894		1, 013, 894	District of Columbia	445, 908	53, 935	499, 843
Missouri	1, 451, 699	46, 475	1, 498, 174	Hawaii	154, 204	52, 300	206, 504
Montana	94, 016	13, 590	107, 606	Puerto Rico	593, 322		593, 322
Nebraska	1, 615, 588		1, 615, 588				
Nevada	113, 842		113, 842				

A Review of the Literature

Survival of Enteric Organisms in Sea Water

By ARNOLD E. GREENBERG, S.M.

THE increased use of ocean beaches and tidal areas for recreational activities and commercial shellfishing, coupled with the increased volume of sewage being discharged into the ocean and the heightened interest in general pollution control, has served to make the problem of salt water contamination acute. This is especially true in a coastal area such as California, which is experiencing a tremendous population growth.

Although the problem of controlling this contamination is basically an engineering one, a public health laboratory can be of real assistance in compiling and evaluating available information on the occurrence and survival of enteric organisms in sea water. Consequently, a review of the literature is reported by the division of laboratories of the California State Department of Public Health.

The reader's attention is called to two references which are of particular interest and value. These are Zobell's Marine Microbiology (*1*), a book which deals with the entire problem of micro-organisms in the sea, and Moore's comprehensive review on the contamination of ocean beaches (*2*).

Mr. Greenberg was appointed chief, sanitation laboratory, division of laboratories, California State Department of Public Health in February 1955. Formerly research microbiologist, University of California Sanitary Engineering Research Laboratory, Mr. Greenberg is also author of papers on biological stabilization of industrial wastes, biological treatment of radioactive wastes, and reclamation of sewage water.

Some of the Early References

For more than half a century it has been known that sea water can be significantly contaminated by human wastes and that this contaminated water may be a factor in the transmission of enteric diseases either through the direct use of the water or indirectly through shellfish which have been exposed to it. The first study on this subject was reported in 1885 by Nicati and Rietsch (*3*), who were able to recover the cholera vibrio from the water of the old harbor at Marseilles during a cholera epidemic. In a series of laboratory experiments they showed that the survival of *Vibrio comma* varied in different waters. For example, the organism could be recovered from sterilized harbor water 81 days after inoculation, while in sterilized water from the open sea the survival time was reduced to 64 days. In polluted fresh water, however, the organism could not be recovered after 32 days.

In studying the Bay of Naples, de Giaxa (*4*) determined that enteric bacteria die off rapidly in the sea. In heat-sterilized sea water the typhoid bacillus and the cholera vibrio survived 25 and 36 days, respectively, while in raw sea water they persisted for only 9 and 4 days. He found that the total number of bacteria markedly affected the survival of the cholera bacillus; there was an inverse relationship between total bacterial count and survival time. He isolated a number of strains of marine bac-

teria which possessed definite antagonistic activity for the cholera bacillus and also for the nonenteric anthrax bacillus. De Giaxa concluded that water of the open sea could probably not be a means of spread of disease but that, in spite of the relatively rapid death rate in harbor water, such water might be infectious. He also indicated that fish and shellfish might be involved in disease transmission.

Fränkel (*5*), in a like manner, recovered cholera bacilli from the harbor at Duisberg, presumably after contamination of the water by the discharge from a ship on which cholera was present among the crew.

In connection with investigations on the contamination of shellfish and the possibilities of purifying them, a number of observers commented on the survival of enteric pathogens in sea water.

Conn (*6*) cited Burdoni, who showed that the typhoid bacillus would live in sea water for 14 days.

Foote (*7*) noted that, in raw brackish water with a salt content of 0.06 to 0.15 percent, the survival of typhoid organisms was a function of temperature, there being greater survival when the temperature was above freezing.

Reille (*8*) stated that, according to his experiments, sea water was favorable to the survival of typhoid bacteria.

Boyce and Herdman (*9*), on the other hand, claimed that typhoid bacilli will not flourish in clean sea water, and Klein (*10*) observed that sea water had a "powerful destructive action" on *Salmonella typhosa* but that survivors could be recovered even weeks after the collection of samples of heavily infected water.

Later, Winslow and Moxon (*11*), during a study of bathing beaches in New Haven Harbor, Conn., were able to recover large numbers of coliform bacteria. Although they did not discuss the factors which affected the coliform numbers, they did mention that tides and winds played a part in the distribution of bacteria. A combination of flood tide and onshore wind produced the least dispersion and the highest counts.

In a survey of sewage outfalls in Los Angeles, Knowlton (*12*) found that the coliform count decreased more rapidly than could be accounted for by dilution alone. After collecting samples with high coliform counts at bathing beaches distant from the outfall, he concluded, "These conditions lead me to believe that *B. coli* contamination may be caused by bathing only."

Survival in Sea Water

It is obvious from these earlier references that an appreciation of the problem existed long before there were adequate means for studying it. Conflicting reports on the effect of sea water on enteric micro-organisms pointed up the need for much additional work. Although subsequent studies did not all agree in their results, they have shown conclusively that there are factors present in sea water which decrease the survival of enteric organisms.

Trawinski (*13*), from his observations of the survival of various enteric pathogens in sea water and in the water from sewage outfalls, found that several members of the typhoid group survived for shorter time periods in the outfall water than in water from the open sea.

Burke and Baird (*14*) reported that fresh water bacteria could survive equally well in fresh or salt water.

Kořínek (*15*), after attempting to grow a number of fresh water and soil bacteria in media made with sea water, concluded that, although the micro-organisms could grow quite well on a sea water medium, in nature they have only a latent development in the sea.

The cholera vibrio was observed by Kiribayashi and Aida (*16*) to survive, on the average, for only 10 days in the water of Keelung Port, Formosa, but in the laboratory it survived longer.

In a series of carefully conducted experiments Beard and Meadowcraft (*17*) studied the survival of pure cultures of *S. typhosa* and *Escherichia coli*. The organisms were put into cells made essentially of a semipermeable membrane, and the cells were suspended in San Francisco Bay. After 35 days no typhoid bacilli and few coliforms could be recovered from the cells.

Experiments using laboratory cultures of the test micro-organisms are of questionable value since it has been shown that laboratory-propagated strains have a greater resistance than naturally occurring bacteria (*2*, *18*). The re-

sults of such experiments may, therefore, have little sanitary significance.

Zobell (*18*) avoided this objection by using sewage bacteria directly, without cultivating them in the laboratory. Comparing the survival of these bacteria in sea water and sewage-diluted sea water, he found that a concentration of 5 to 10 percent of sea water favored the survival of bacteria, whereas higher concentrations produced rapid killing. In 75 percent sea water the bacterial count was reduced to 39 percent of the original in 2 hours.

The general problems of the discharge of sewage into the Atlantic and Pacific Oceans have been discussed, respectively, by Weston (*19*) and Warren and Rawn (*20*). They indicated that enteric bacteria occur in significant numbers only in such places as tidal zones, harbors, and bays.

Zobell (*21*) confirmed these observations by finding coliform bacteria absent in 961 samples taken from the open sea but regularly present in samples from bays and estuaries. He attributed the die-off of coliform bacteria to the paucity of organic matter and the activity of predatory organisms, believing sea water itself, however, to be slightly toxic for *E. coli*.

Carpenter, Setter, and Weinberg (*22*) observed that sea water has considerable disinfecting properties on fresh sewage organisms. In their experiments an average of 80 percent of the organisms died in 30 minutes.

The Massachusetts Department of Public Health (*23*) and Weston and Edwards (*24*) have reported the results of an investigation made at the Lawrence Experiment Station. After mixing sewage with sea and tap water, at rates of 0.5, 1.0, and 1.5 percent, the total number of bacteria and number of coliforms were followed for 4 days. Both in the raw sewage and the sewage-tap water mixtures the bacterial count decreased slowly, but in the sewage-sea water mixture the decrease was very rapid. No coliforms survived beyond 4 days in the latter mixture.

During the course of examining the Santa Monica beaches, the California Department of Public Health (*25*) showed that marked coliform reductions occurred in samples of contaminated sea water held for 24 hours. At refrigerator temperatures, from 5 to 20 percent of the coliforms survived. At room temperature, however, only 1.0 to 2.5 percent of the original number of coliform bacteria could be recovered after 24 hours.

Stryszak (*26*), working in Poland with several *Salmonella* species, found that the waters of the Gulf of Gdansk (Danzig) produced a rapid kill when the temperature was between 5.5° and 18.5° C. Lower temperatures resulted in reduced kills.

Ketchum and his colleagues (*27*), in the first of several papers from the Woods Hole Oceanographic Institute, concluded that coliform bacteria rapidly disappeared from normal sea water. This disappearance was more rapid than could be accounted for by such mechanical factors as dilution or sedimentation.

In a later paper from the Woods Hole laboratory (*28*), the bactericidal action of sea water was shown to be the most important factor in decreasing coliform counts. The total reduction was 99 percent.

Buck, Keefer, and Hatch (*29*) found that coliforms could persist in estuary water for longer than 200 days.

The North Sea has been examined by several investigators who recovered a number of pathogenic enteric bacteria (*30*). Buttiaux and Leurs (*31*), for example, found *Salmonella montevideo*. Their experimental work indicated that with 3 species of *Salmonella* there was more than 90 percent kill in spring water in 44 hours but that in sea water the number of survivors was greater.

As a result of studies similar to the ones mentioned, attention has turned to the reasons for the bactericidal effect of sea water and the quantitative determination of its importance. The explanations suggested by Waksman and Hotchkiss (*32*) for the low numbers of viable bacteria in water have been summarized as follows:

1. The presence in sea water of toxic substances which are destructive to bacteria under natural conditions.
2. The presence of bacteriophage in the water.
3. The adsorption of the bacteria by the sea bottom and their sedimentation.
4. The bactericidal effect of sunlight.
5. The consumption of the bacteria by protozoa and other small animal organisms.

6. The possible presence in the sea of inactive bacteria which are capable of developing only under more favorable conditions of temperature, aeration, and food supply.

7. The lack of sufficient nutriment in the water.

8. The antagonistic relations of other micro-organisms.

It will be convenient to discuss the more important of these categories separately.

Presence of Inorganic Salts

The most potentially toxic substances present in sea water, on the basis of concentration, are inorganic salts. The salinity of surface sea water is given by Zobell (*1*) as from 3.3 to 3.7 percent. Near river mouths and other areas of fresh water dilution, this concentration of salts may be appreciably reduced. In inland seas, it may be greater. The effect of high salt concentrations on fresh water or enteric bacteria may be due to differences in osmotic pressure or to the presence of specific inhibitory salt concentrations.

As early as 1890, de Freytag (*33*) investigated the effect of concentrated solutions of sodium chloride on a variety of bacteria. Unfortunately, he did not mention the salt concentrations used, nor did he compare the survival times with any fresh water controls. He found that, although the typhoid bacillus survived for longer than 5 months, the cholera bacillus died out within 6 to 8 hours.

After comparing the growth of several fresh water bacteria on media containing varying concentrations of sea water, Kořínek (*15*) concluded that the test organisms could grow quite well on a sea water medium. Furthermore, sea water exerted no marked autolytic effect.

Reporting on the extension of this work, Kořínek (*34*) noted that fresh water bacteria usually do not compete successfully in the sea with marine bacteria.

The survival of bacteria in an 0.85 percent saline solution and in distilled water was compared by Ballantyne (*35*), who showed that in either menstruum—in the absence of nutrients—micro-organisms, including *S. typhosa*, were able to survive up to 32 months.

Burke and Baird (*14*) assumed that the principal factor of difference in fresh water or salt water survival of bacteria was the concentration of sodium chloride. The results they obtained, however, did not support this assumption. Although no data are given in their report and the test micro-organisms are not identified, they claimed that fresh water bacteria survived in sea water nearly as long as in tap water. The length of survival depended on both temperature and the presence of organic matter. Nutrient broths prepared with 2 to 4 times the concentration of salt present in sea water permitted the extended survival of of fresh water bacteria. Sea salts other than sodium chloride did not affect viability. Thus, in general, these authors support the viewpoint that inorganic salts affect slightly, if at all, the survival of nonindigenous bacteria in the sea.

Zobell and Feltham (*36*) in a discussion of marine bacteria mentioned that "the toxicity of sea water for nonmarine bacteria is due not only to its high salt concentration, but to some other factor as well," indicating that they considered the salts to exert some toxic effect.

In a later work Zobell (*18*) studied the survival of sewage bacteria in artificial and natural sea waters as well as in sodium chloride solutions. He showed that the death rates in the synthetic solutions were markedly different from those in the chemically similar sea water.

The Great Salt Lake in Utah obviously does not contain sea water, but its salt concentration of more than 25 percent makes it interesting in this connection.

Zobell and his associates, Anderson and Smith (*37*), in an attempt to grow *E. coli* on a lactose medium made with lake water, were unable to observe any gas production or to recover viable coliforms. They stated that the lake water would kill over 95 percent of the sewage bacteria in 1 minute.

Conflicting results, however, were obtained by Fraser and Argall (*38*), who claimed that *E. coli* was not rapidly killed and that the length of the survival time increased as the temperature decreased.

In summary, it would appear that the usual concentration of salts present in sea water may exert some bactericidal action, but that this tox-

icity factor is insufficient to account for the observed death rates or survival times.

Presence of Other Toxic Substances

The presence of other toxic substances has been stressed in recent years.

Zobell and Feltham (*36*) were among the first to make specific mention of the possible presence of such substances.

Waksman and Carey (*39*) spoke of "certain controlling factors" injurious to free bacterial development but made no attempt to characterize them.

Careful experimental work is described in an article by Zobell already cited (*18*). The test bacteria were submerged in the sea within Coors porous porcelain filter tubes impregnated with collodion. This semipermeable membrane permitted the passage of chemical substances from the sea water into the bacterial suspension but did not permit bacterial passage into the sea water. It was found that the death rate of sewage bacteria suspended in autoclaved sea water or sea water which had been passed through a Berkfeld filter was lower than that of bacteria in raw sea water.

A similar observation was made by Kiribayashi and Aida (*16*), who noted that cholera vibrios survived longer in boiled and sterilized sea water than in the untreated liquid.

Beard and Meadowcraft (*17*) concluded that the death rate of *E. coli* and *S. typhosa* was higher in unfiltered sea water than in filtered sea water.

Krassilnikov (*40*) found that a bactericidal factor also was present in the waters of the Black Sea. This factor was active against *E. coli* and was removed by passage of the water through a Seitz filter as well as by boiling or by heat sterilization, and its effect was overcome by the addition of organic matter. At a concentration of 0.1 percent of peptone it was completely absent.

The data of Ketchum, Carey, and Briggs (*27*) showed that there was a bactericidal principle in sea water which could be destroyed almost completely by autoclaving but only partially by boiling. This factor was not related in any simple way to the chemical composition of sea water. They suggested that the factor may be an antibiotic substance or an autolytic or degenerative product of the coliforms themselves.

In a continuation of this work, Vaccaro, Briggs, Carey, and Ketchum (*41*) determined that sea water treated by boiling, autoclaving, pasteurizing, and chlorinating had reduced bactericidal activity. The addition of organic matter also produced reduced activity although not as much as did sterilizing the sea water.

As part of an investigation of the viability of sewage bacteria with respect to shellfish purification, Sherwood (*42*) found that growth generally occurred in autoclaved sea water but not in raw sea water. By passing the treated water through sterile porcelain filters the effect of autoclaving was removed. Treated sea water which supported the growth of *E. coli* would not permit the persistence of heavy infections of *S. typhosa* or *Salmonella paratyphi* B.

De Balsac, Bertozzi, and Gaudin (*43*) observed that the bactericidal activity of sea water was independent of salinity, decreased with sample age until it disappeared after 8 to 10 days, was thermolabile, and persisted after passage of the water through a Chamberland filter.

It has clearly thus been established that sea water contains a potent toxic factor which is thermolabile. The isolation and identification of this factor has as yet to be accomplished.

Presence of Bacteriophage

Numerous investigators have confirmed the presence in sewage of bacteriophages active against enteric bacteria.

As early as 1896 Hankin, cited by d'Herelle (*44*), noted the effects of bacteriophages.

Arloing, Sempé, and Chavanne (*45*), as a result of their experiences, believed that the disappearance of fresh water bacteria in the sea was due to the action of specific phages.

Guélin (*46*), who is one of the foremost students of bacteriophage and its sanitary significance in water, found that bacteriophages active against the coli-typhoid dysentery group were present in the port of Roscoff (France). The number of phages varied directly with the degree of sewage contamination. However, no conclusions were drawn as to the role these

phages play in the destruction of enteric bacteria.

De Balsac and co-authors (*43*) believed that the bactericidal activity which they observed was not due to bacteriophages.

There are too few data available to be able to draw sound conclusions on the role played by bacteriophages in limiting the survival of enteric bacteria in sea water. The indications, however, are that the phages are not of the first order of importance.

Adsorption and Sedimentation

[illegible] observed that the concentration of bacteria in the Gulf of Naples was highest in the bottom muds. Although he attributed this distribution to the growth and multiplication of indigenous bacteria, he showed that the mud could take up bacteria which derived from the mainland.

Rubentschik, Roisin, and Bieljansky (*48*) believed that the disappearance of coliforms introduced into the limans or salt lakes of the Odessa region, by drainage from sewage fields, was due primarily to the adsorption of the bacteria on muds. The adsorption capacity of ground sediments in the Chadjibey liman for *E. coli* was quite high. The shallowness of the lakes, particularly near the shore, and the tidal action were responsible for rapid mixing of sediments with the surface water. This in turn produced conditions favorable to adsorption of bacteria.

Waksman and Vartiovaara (*49*) also found that marine muds had marked adsorptive effects on bacteria. Sand, on the contrary, possessed slight adsorptive properties.

These results are in accord with accepted theories of the nature of soil. Clay and silt, which constitute a major portion of the mud, are electrically charged, and hence, are adsorptively active. Sand, however, not only has a larger particle size and, thus, has less relative surface area, but it is also electrically neutral.

According to the theory held by Dienert and Guillerd (*50*), sea water is neither antiseptic nor inimical to *E. coli*, but sewage discharged into the sea is purified by sedimentation as well as through the activity of predatory organisms.

In a careful study Weiss (*51*) determined the adsorptive effect of silt taken from rivers and estuaries. He showed that the degree of adsorption was a function of particle size and the physicochemical nature of the particle. The turbidity found in many natural waters was high enough to yield measurable adsorption of *E. coli*. The end result of this adsorption of bacteria by relatively heavy particles is an increase in the rate of bacterial removal by sedimentation. However, sea water generally reduced the adsorptive capacity of silts, and, furthermore, desorption may have taken place.

It may be concluded that adsorption and sedimentation of enteric organisms do occur, but they will be affected by the nature of the bottom deposits, the rate of desorption, and the rate of water movement, that is, the factors adversely affecting sedimentation. Adsorption and sedimentation do not, in themselves, affect the survival of bacteria but merely tend to remove the organisms from suspension and concentrate them in bottom deposits where they may continue an active existence.

Sunlight and Temperature

Although a considerable amount of information on the bactericidal effects of sunlight has been accumulated, there are few references dealing with this effect in sea water.

Gaarder and Spärck (*52*) have studied this phenomenon and considered it to play a significant part in the destruction of organisms in the sea. In all likelihood it is a contributing factor in bacterial destruction but of secondary importance only.

The effect of temperature has been mentioned in some of the references already cited.

Burke and Baird (*14*) found that fresh water bacteria inoculated into sea water survived longer at 20° to 22° C. than at 7° to 12° C.

Waksman and Carey (*53*), in studying the effect of storage of sea water on bacterial multiplication, noted that temperature had a marked effect on changes in numbers of bacteria. As the temperature increased to an optimum, the rate of multiplication also increased.

Fraser and Argall (*38*) reported that in waters of the Great Salt Lake few *E. coli* survived for longer than 8 hours at summer tem-

perature; however, at 6° C. approximately 50 percent survived a 24-hour exposure.

Ballantyne (*35*), in his work with physiological saline, found that *S. typhosa* also survived longer at low temperatures.

In spite of the conflicting reports on the effect of temperature on bacteria in sea water, there is no reason to believe that its effect will be materially different than it is in fresh water or any other aqueous system. Unfortunately, such information is equally conflicting, so that, in any given environment at ordinary temperatures, it is impossible to predict the effect of temperature changes other than to say that the tendency for increased survival is greater at lower temperatures.

Aeration and Food Supply

The dissolved oxygen concentration, which is a function of temperature, pressure, salinity, and biological activity, may be used to measure the degree of water aeration.

The only information available on the relationship between micro-organisms and oxygen content in natural sea water is the observation by Buttiaux and Leurs (*31*) that oxygenation of sea water did not affect the survival of *Salmonella typhimurium*.

Waksman and Carey (*53*) showed clearly that in stored sea water the oxygen content affected bacterial multiplication.

Zobell and Anderson (*54*) attributed this increase in numbers to the effect on the solid surface of the container, rather than to oxygen tension.

Under most circumstances survival, and more especially reproduction, of bacteria is associated with available nutrient materials.

Russell (*47*) found that multiplication of bacteria was quite marked in marine muds which are relatively rich in organic matter. He did not comment on the survival of bacteria in waters containing different concentrations of organic matter.

Burke and Baird (*14*) believed that the presence of organic matter in sea water would increase the survival time of nonmarine bacteria.

Waksman and Carey (*39*), in their investigation of the decomposition of organic matter in the sea, concluded that sea water contains enough organic substances in true solution to support an extensive population of bacteria. They did not indicate whether they believed that enteric bacteria or fresh water bacteria could thrive in such an environment.

In another study, Waksman and Vartiovaara (*49*) showed again that rapid and considerable increases in bacterial numbers took place following adsorption of parent bacteria on marine muds. The neutralizing effect of organic matter on the bactericidal principle in sea water has already been mentioned (*40*, *41*).

Steininger (*30*) found that at ebb tide the concentration of protein in the standing water of tidal pools was sufficient to provide favorable conditions for the multiplication of *S. paratyphi* B.

An unsigned editorial in the *American Journal of Public Health* (*55*) commented on the destruction of the bactericidal principle in sea water by autoclaving but not by boiling (*27*) and suggested that instead of being an antibiotic substance this principle was, in fact, not a toxicity but a starvation problem. Thus, chemical compounds present, but unavailable as nutrients to coliform bacteria, were decomposed by the elevated temperature of the autoclave (but not by boiling) and produced products "which enable the coliform bacteria to maintain themselves more efficiently" (*55*).

It should not be concluded that under all circumstances the chance of survival or of reproduction of the enteric bacteria is improved by the presence of organic matter. In the event that there is sufficient organic matter present to support growth, a competition between enteric organisms and saprophytes indigenous to either the fresh water or marine habitat would follow. Generally, the enteric organisms would be unequal to the competition. If we consider that the total number of bacteria in the sea is a direct function of the concentration of organic matter, it follows that there will be more competitors of the enteric bacteria as more organic substances occur and that these other organisms, either directly or indirectly, will reduce the growth and survival of the fecal bacteria. This has been shown by de Giaxa (*4*) and Kořínek (*34*).

Antibiotics and Animal Predators

De Giaxa (*4*) was the first to report the existence in the sea of bacteria antagonistic to *V. comma*. After growing these unidentified organisms in mixed culture with *V. comma*, he was unable to produce an experimental infection in animals. Pure cultures of the vibrio were, on the other hand, quite infectious.

Kiribayashi and Aida (*16*) assumed that the toxic principle in sea water was associated with the presence of saprophytic micro-organisms.

Zobell (*18*) and Waksman and Hotchkiss (*32*) observed the bactericidal action of sea water. Waksman and Hotchkiss did not attribute this action to a chemical factor. They found that the toxic agent did not interfere with the decomposition of organic matter as measured by oxygen uptake. Since the reduction in the number of bacteria was not accompanied by a decrease in oxygen consumption, they concluded that other living organisms, namely protozoa and other nannoplankton, were responsible for the reduction.

This point of view was held also by Stryszak (*26*), who believed that the effect of low temperatures on the increased survival of *Salmonella enteriditis*, *S. typhosa*, and *S. paratyphi* B was due to the thermal inactivation of predatory protozoa rather than to any more direct temperature effect. Similarly, when the concentration of organic matter increased, the population of saprophytes and animal predators did the same. From this effect Stryszak inferred that the predators were most important in the elimination of enteric pathogens from the sea.

Rosenfeld and Zobell (*56*), in comparing the bactericidal properties of sea water and cultures of antagonistic marine bacteria, found that both the sea water and the cultures suffered losses in activity after filtration through bacteria-proof filters and that both were, on the whole, active against the same organisms. Most of the antibiotic-producing bacteria belonged to the genera *Bacillus* and *Micrococcus*. Although antibiotic activity against *Proteus* sp., *S. typhimurium*, and *Shigella paradysenteriae* was not shown, activity against several gram-positive bacteria was demonstrated. It was concluded that the bactericidal activity of sea water "may be at least partially due to an autochthonous flora of antibiotic-producing organisms" (*56*).

Vaccaro and co-workers (*41*) believed that a normal population of marine bacteria was a necessary condition for bactericidal activity of sea water. They said:

". . . the preponderance of evidence thus points toward an antibiotic action, but it can not be stated categorically that all other possibilities have been excluded. The character of the activity is such that it suggests that the bactericidal substance is present in very small concentration."

Ketchum, Ayers, and Vaccaro (*28*) completed a study of a tidal estuary with a mathematical analysis of the factors contributing to the decrease in coliform counts and showed that bactericidal action was considerably more significant than either dilution or predation. Unevaluated factors were from 3 to 7 times as effective as dilution but were not as effective as bactericidal action in reducing counts.

From the foregoing it may be concluded that the single most important factor in reducing the number of enteric bacteria in sea water is a biological one and most likely is the result of the production of antibiotic substances by marine bacteria.

Summary and Conclusions

From a review of the literature on the survival of enteric organisms in sea water, it is apparent that these organisms can create a health hazard in estuaries, bays, and especially beaches. The rate of disappearance of the fecal bacteria is greater than that which would be expected from dilution alone. A number of factors are implicated. These include the production by marine bacteria of unidentified, heat-labile antibiotic substances; and adsorption and sedimentation, predation, and competition for the limited food supply. The net result is a partial or complete disinfection or self-purification of sea water. Nevertheless, this bacterial destruction should not be relied on as the sole protection offered to users of sea water.

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CDC Course in Epidemiology for Nurses

A 3-week course in communicable disease control is offered by the Communicable Disease Center, Public Health Service, Atlanta, Ga., to public health nurses and instructors in communicable disease nursing, beginning May 6, 1956.

The course, designed to increase the technical knowledge and skills of nurses in the prevention and control of communicable diseases, will emphasize epidemiological principles and techniques.

To a limited number of students, field experience under supervision may be available following the completion of the course, May 26.

For further information and for application forms, those interested should write to the director of public health nursing in a State health department or to the Chief, Nursing Section, Epidemiology Branch, Communicable Disease Center, Public Health Service, 50 Seventh Street, N. E., Atlanta, Ga.

The methods and plan of a pilot study to obtain definitive data on the effects of air pollution on the health of selected cardiac and respiratory patients in their homes.

Measuring Reactions to Air Pollution

By JOHN J. PHAIR, M.D., and MAURICE L. THOMSON, M.B., Ph.D

THE nature and extent of the effect of airborne contaminants upon man's health are still matters for speculation. Most of the available and very scanty data have been gathered from three sources—the broad field of industrial toxicology, the several studies of catastrophes involving large groups subjected to extraordinary exposures (epidemic situations), and in the analyses of morbidity and mortality records.

Clinical and toxicological studies have their principal application in the protection of the industrial worker. The studies usually are supplemented by experimental investigations with animals and men to permit controlled observations of changes resulting from contacts with noxious materials. However, toxic and irritant materials rarely give trouble in an industrial environment until they are present in concentrations far greater than ever recorded in the usual urban situation. Consequently, values observed in the plant or obtained in the laboratory are not easily applicable to community problems.

An epidemic is defined as an unusual and widespread occurrence of disease. The catastrophic smog incidents and various accidents fall into this category. Since they represent the extremes, the amount of usable information contributed is therefore necessarily limited.

Analyses of excess morbidity and mortality rates in areas of low and high pollution unfortunately have definite deficiencies. If such data are used, we must assume that uncontrolled factors, such as age, race, and socioeconomic status, have no significance. This assumption obviously is not warranted in the face of considerable evidence to the contrary.

Dr. Phair is professor of preventive medicine and director of that division, University of Cincinnati College of Medicine in Ohio. Dr. Thomson is assistant professor of preventive medicine at the college and senior lecturer of applied physiology, on leave, London School of Hygiene and Tropical Medicine, England. *This paper is based on an address given at the 121st annual meeting of the American Association for the Advancement of Science, December 1954, at Berkeley, Calif. The work was supported in part by a research grant by the National Institutes of Health, Public Health Service.*

Epidemiological Approach

Although the three sources of data have certain applications, they do not give enough information to permit the formulation of acceptable solutions for the low-level air pollution problems of cities (endemic situations). Since these situations concern the whole community, population studies using epidemiological techniques immediately come to mind. Today, we expect that a rounded investigation will make use of all approaches—clinical, experimental, statistical, and epidemiological studies of epidemic and endemic exposures.

The starting point for the classical studies of infectious disease usually has been an identifiable clinical reaction. At first we search for the agent or, if it is known, the demonstration of its characteristics and mode of transmission. Later, we try to determine host, parasite, and environmental factors governing the incidence and prevalence of the disease.

However, man is resistant and resilient. He can withstand and adapt to stresses and insults. This ability differs with age, sex, race, nutritional state, and other variables, but man's reactions are frequently subclinical, nebulous, or transitory. This is particularly true of exposures to toxic materials in the low levels found in community air contamination.

Accordingly, some workers believe air contaminants in low concentrations will never be demonstrated as the primary cause of disease but can be evaluated only as possible contributing factors. The epidemiologist learns early to accept the concept of disease as a summation of a complex of host, agent, and environmental factors. However, the community and industry insist upon exact quantification of single variables, particularly in pollution problems.

Past and present attempts to apply epidemiological techniques to air pollution studies have been elementary and limited in scope. These attempts have dealt with persons in respiratory contact with a complex of materials in widely varying degrees of duration and concentration. The objective usually has been to relate all illnesses having any possible relationship to these exposures, however slight. This goal has been forced upon the investigators because they must work without a definite clinical reaction, specific or nonspecific, associated with such exposures. Accordingly, their findings are received and interpreted with enthusiasm or with doubt, depending upon the desires and motives of their audience.

Today, communities require the extension and refinement of epidemiological observations by carefully comparing selected components of a population exposed to accurately described environmental conditions. The proper selection of indexes, therefore, is all-important. The difficulties encountered in the use of morbidity and mortality rates for the common respiratory and cardiac diseases are well known.

Still, the average duration of upper respiratory diseases or asthmatic attacks, the mortality rate of individuals with cardiac or pulmonary lesions, and similar measurements may deserve investigation. Whether they will serve or not will require many careful trials. At the moment, no entirely satisfactory study has ever been designed, and it is generally accepted that the search for methods to measure objectively human reactions to air contaminants must continue.

Such studies are not entered into lightly. The goal, essentially, is to relate the incidence, severity, and outcome of a group of clinical reactions, which may have a variety of etiological agents, to the presence or absence of a combination of air pollutants which may vary, absolutely or relatively, from time to time. Since precise morbidity surveys are costly and difficult, and the objectives are so illusory, few have been attempted. None thus far have succeeded in relating human disease unequivocally to differences in air pollution.

Preliminary Planning and Observations

Recognizing the limitations of analytical observations, a project to determine the feasibility of morbidity surveys was planned. The primary objective was to determine if practical investigations could be designed to permit reasonably accurate descriptions of the incidence, prevalence, and prognosis of disease in a population exposed to varying concentrations of air contaminants under urban conditions.

A field team, working under the close supervision of a competent advisory committee, was formed to conduct appropriate trials and test procedures and to appraise possible indexes. It seemed desirable and requisite to explore carefully all the various approaches before planning or embarking on a large-scale investigation.

One reason for this attitude was the considerable doubt of the validity of characterizing atmospheric pollution as high or low. The extreme variability of measurements and the significant overlapping of the observations have long been recognized. It seemed essential,

therefore, to obtain more specific estimates of the environment for correlation with the patients' reactions. Another reason was the resistance demonstrated daily by smokers and workers exposed to relatively high concentrations of a great variety of irritants. This implied that the observation of apparently healthy or even somewhat incapacitated individuals would not give significant results unless sizable samples were followed for many years.

However, some persons are unusually susceptible—the newly born and those with chronic cardiac or respiratory diseases. Their marked sensitivity due to a low respiratory reserve was notable in the epidemic incidents of London, Donora, and the Meuse Valley. A further advantage can be gained by restricting the choice of subjects to such persons. Since they may be confined or at least significantly disabled, they tend to remain in one locale instead of spending one-third of the day at work, one-third at home, and the remaining third elsewhere. Because exposure in each locale usually differs widely both in degree and kind of pollution, the use of patients with limited mobility diminishes the error of extrapolating environmental measurements made at 2, 3, or more external sampling stations.

As the planning progressed, various considerations led the investigative team to an even more circumscribed approach for the initial effort—use of exact measurements of a small group of selected individuals and their environment. We now believe that until such observations are available, large field surveys cannot be properly planned or conducted with any hope of success.

The Pilot Study

In our pilot study in Cincinnati, the pollution to which the test subjects were exposed was measured specifically. Persons with obviously diminished respiratory reserve, as indicated by breathlessness, were chosen and followed during January through April 1955, in order to include several periods of high concentrations of air pollutants. These carefully selected individuals were believed most likely to react clinically to variations in degree and amount of contamination.

The selected goal was to prove or disprove the hypothesis: "Fluctuations in air pollution, as measured by soiling of filter paper, are negatively correlated with variations in the patients' well-being as assessed subjectively by diaries and questionnaires and objectively by instrumental methods." Other useful observations were to be made at the same time, for example, the effect of temperature and humidity on cardiorespiratory patients.

We also hoped to find a more precise relationship between air pollution and well-being than is possible by designating pollution as high and low. Carefully observed clinical responses to many different degrees of air contamination might supply a curve demonstrating a more precise relationship. If a specific association could be demonstrated by such an

Nature of disability of 28 patients studied simultaneously, January–April 1955

Age	Sex		Nature of disability					
	Male	Female	Cardiac		Chest		Cardiac and chest	
			Male	Female	Male	Female	Male	Female
50–54	1	3	0	2	1	0	0	1
55–59	5	4	3	1	1	2	1	1
60–64	1	2	0	2	0	0	1	0
65–69	2	2	2	2	0	0	0	0
70–74	2	1	1	0	1	1	0	0
75–79	1	1	0	0	0	0	1	1
80–84	2	0	1	0	1	0	0	0
85–89	1	0	0	0	1	0	0	0
Totals	15	13	7	7	5	3	3	3

approach, the methodology for further studies could be arranged readily. A failure to show an association with these precise measurements would have a greater significance.

Patient Selection and Followup

Twenty-eight persons were recruited through out-patient departments, private physicians, and institutions for the aged (table). This was the smallest sample expected to supply definitive results. Twice as many would have been better. However, in addition to limitations imposed by the cost of instruments, serious difficulties were encountered in recruiting the proper type of cooperative patient who lived in a significantly polluted area.

Practical considerations required modification of the original criteria. One patient was hospitalized almost immediately, and it was necessary for various reasons to drop four more patients and to select others. Changes of this nature were required throughout the trial. Forty patients were followed for varying periods. Immobilization of the patient in the home became more important, not only because the measurement of atmospheric pollution was most specific there, but also because failure to contact the patient at the proper time upset the statistical plan and increased the work of the staff of visiting nurses.

The lung function tests employed were better adapted to following the progress of chest than of cardiac patients. However, this series contains few chest patients, although they were chosen whenever possible, because:

1. Such individuals appear to remain at work or at least spend more time outside their homes, until the disease becomes advanced and they are hospitalized.
2. They tend to reside in the less smoky areas of the town.
3. Epidemic smog incidents have indicated that cardiac patients are almost equally susceptible to atmospheric pollution.

Furthermore, tuberculous patients were deliberately avoided because the disease is frequently focal. Allergic asthmatics were likewise excluded because, ordinarily, allergens could be expected to vary independently of atmospheric pollution.

In the plan, the group was to be under observation by December 1, 1954. Unavoidable delays in assembling the equipment and the need for soundproof cabinets forced postponement until early January 1955. We hoped for the occurrence of a sufficient number of inversions to permit an appraisal of the value of this approach.

In this experimental effort, we were primarily concerned with variations in the individual patient's condition. The results do not depend upon changes in the sensitive individuals as a group from the beginning to the end of the trial period or on terminal differences between groups of patients exposed to different levels of air contamination. Thus, the weekly observations of the individual subjects are much more important than his physical condition before and after the trial period. Nevertheless, the clinical assessments were made as complete as possible.

The most important part of the pilot study was to determine and record at frequent intervals changes, however slight, in the patients' well-being. The success or failure in this effort depends largely upon such observations. The patients were asked to maintain a diary recording the occurrence or exacerbation of 12 symptoms. These were selected principally to elicit any unusual irritation of the upper respiratory tract and to record the day-by-day state of the cardiorespiratory system. Some were included to test the validity of the record.

Visiting nurses recorded the pulse, temperature, and respiratory rate, checked the diary, and noted any relevant change in the environment. To reinforce the subjective findings, they made certain objective measurements of lung function at predetermined intervals. If such epidemiological investigations of air pollution are to be pursued properly in the future, simple portable tests, readily adaptable to field requirements, must be developed. This has been given much thought, and some work has been done. Much more work is required, and we believe that this pilot study will be justified by indicating fruitful approaches to this question alone. However, the following were selected arbitrarily for objective measurements.

Timed vital capacity. The proportion of the total vital capacity expelled in 1, 2, or 3 seconds can be determined readily by the Gaensler vital-

ometer. For this investigation, we believe that a single interval will be sufficient but the most informative of the three will be chosen after preliminary trials with each subject.

Oximeter. In spite of many known sources of inaccuracy, the oximeter test of blood oxygenation has proved useful for following the progress of patients if cross-checked by simultaneous arterial puncture and gas analysis. In this study where variability from time to time was all-important and the other errors were not critical, it offered the advantage of being independent of patient cooperation, but the value of the observations is questionable.

Respiration. The maximum inspiratory and expiratory pressure test, not yet adequately evaluated, was included because of the rapidity and ease of use in the patient's home. It furnished some information on the relative contribution of viscous and elastic components of the lung to the total resistance and served as an index of patient variation.

Measurement of the Environment

Pollutants. We selected the American Iron and Steel Institute (AISI) automatic smoke sampler to estimate the concentration of air contaminants. This device gives an indication of the atmospheric concentration of "smoke" by aspirating air through white filter paper. Transmission of light through the spots obtained was used as a crude index of the amount of pollution in the patients' environment.

Temperature and humidity. Temperature and humidity were recorded by an 8-day automatic thermohygrograph. The temperature was obtained by a bimetallic unit and the humidity by a bundle of human hairs, each operating individual recording pens. These instruments were checked at weekly intervals by more accurate psychrometers and readjusted if necessary.

Location and servicing. Since the protocol required that the patient's environment be continuously sampled, these mechanisms were enclosed in a soundproof box, placed in or near the bedroom. Although the noise level was not great, the need to protect the instruments and to insure the patient against the possible irritation induced by the constant hum and periodic clicks, forced the development of an elaborate cabinet. It also seemed wise to fuse all circuits to avoid damage to the home or instrument wiring. The nurses checked and serviced the devices at each visit. The machines recorded for a week.

Other measurements. Although smoke was chosen as a crude index of the pollution faced by the patient, it is not to be inferred that it is the only, or even the principal, injurious component. Four Wilson sequence samplers were obtained to ascertain the extent of correlation between SO_2 (or total acid) and the concentration of smoke. This is a satisfactory instrument, but it is not entirely suitable for home installation because of the noise of the pump and the need for daily servicing. Therefore, they were used only in carefully selected locations. There was reason to assume that, except in the neighborhood of a major effluent, the levels of smoke and SO_2 would correlate reasonably well in Cincinnati.

The observations were adjusted to the community measurements of the United States Weather Bureau, the Cincinnati bureau of smoke inspection, and the Public Health Service Robert A. Taft Sanitary Engineering Center. High volume samples were obtained at five points. There were 20 dustfall stations and 3 smoke samplers in regular operation. These records of the external air in Cincinnati were correlated with the household observations.

Statistical Analysis

The technique of multiple linear regression will be used to evaluate the results. A separate regression analysis will be performed for each of the pulmonary function tests and for certain groupings of the subjective symptoms. We assumed that the value of each of these tests and symptoms can be represented by a model of the form

$$Y_i = B_0 + B_1 X_1 + B_2 X_2 + \ldots + B_{47} X_{47} + E_i$$

where Y_i is the ith observation of one of the tests or symptoms; and X's are certain reduced variates identifying lapse of time, patient, and environmental conditions at the time of measuring Y_i or during the preceding week; and E_i is the observational error. The effect of time will be removed by a second order polynomial; the effect of absolute differences in patient's

level of response will be removed by the corresponding terms in the model for each patient; and relevant environmental conditions are also represented in the model. In the light of these considerations it seems reasonable to assume that the E_i will be normally and independently distributed so that the usual tests of significance can be used. This assumption, of course, can and will be checked.

The sums of squares and cross-products for the variates will be obtained by punch-card equipment, and the resulting matrix will be manipulated with aid of electronic calculation.

Results

It is far too early to report or speculate about the observations. During the course of this initial study, an enormous number of observations were made, and the analyses, as have been indicated, will not be simple nor quickly made. Even this aspect of the project is considered essentially experimental and will require trial with various approaches.

Study Extension and Continuation

From the experiences of the past year, it is obvious that a determined effort should be made to obtain or develop simpler and more sensitive and objective methods for the assessment of respiratory efficiency. For example, the weight of the instruments, particularly the vitalometer, is at the upper limit. Also, it is essential to find a means for measuring the diffusion component of the respiration mechanism in the patient's home. Several other techniques are available, but each must be modified to meet the peculiar requirements of field investigations.

In view of the importance of eye irritation as a symptom in certain situations, we believe it is worthwhile now to consider the development of a quantitative objective method of measuring this reaction to air contaminants. Tentative steps have been made in this direction, but apparently a great amount of careful work will be required.

Furthermore, the continuous recording of the concentrations of particles of respirable size with the AISI samplers in the patient's home, if feasible, should be supplemented by measurement of gaseous acids. Only a brief trial of the Wilson sequence sampler was carried out in this pilot study. Also, no satisfactory method of silencing has been developed, and this defect, coupled with the need of frequent servicing, limits their use in human habitations.

Summary

The desirability for expanding investigations dealing with the many problems of atmospheric pollution has been accepted by all. They rank among the most important challenges remaining in the field of public health today. The immediate need for safe and practical disposal of airborne wastes and for rational controls cannot be ignored by the community, its industries, or the public health agencies.

Many of the proposed solutions are controversial because the reactions of man on exposure to common air contaminants at the low concentrations customarily found have not been described unequivocally. Lacking acceptable clinical evidence either pro or con, reasonable and rational control procedures cannot be instituted. Additional and more detailed epidemiological studies relating the reactions of man to this hazard are urgently needed.

We have outlined the pilot study now in progress in Cincinnati, in which the atmospheric pollution exposure of the subjects has been measured specifically and the effects of various concentrations have been sought in those individuals most likely to show measurable changes. In the event that an association between pollution and well-being is demonstrated, the methodology for further studies can be described easily. It may even be possible to institute an alarm system based on the behavior of cardiorespiratory or other sensitive patients followed in this way. On the other hand, with the precise measurements employed, a failure should have greater significance.

This approach is only one of many; it may succeed or it may fail. However, until human disease can be shown to be related to community air pollution in an acceptable fashion, the controversies regarding the degree and kind of control for air contaminants will continue.

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Environmental Causes of Lung Cancer

By W. C. HUEPER, M.D.

TO BE SCIENTIFICALLY acceptable, any theory on the etiology of lung cancer must reflect a critical, balanced, and competent analysis of the entire epidemiological, medical, and experimental evidence concerning the types and environmental distribution of and contacts with all known or suspected exogenous agents incriminated in respiratory carcinogenesis for environmental, occupational, or medical reasons. It is only through such scrutiny that significant and worthwhile information may be obtained as to the relative role which the various individual respiratory carcinogens have played and are playing in the production of lung cancer. The following facts and observations form an important and integral part of such an assessment.

A large amount of factual and circumstantial evidence of epidemiological, clinical, pathological, and experimental types incriminates a number of general environmental and specific occupational air pollutants in the causation of cancer of the lung. Exposure to these agents exists for considerable parts of the population in general as well as for large groups of industrial workers. Epidemiological observations on hand indicate that only a part of the environmental agents which may cause lung cancer are known. However, an appreciable number of them have been identified, such as dusts and fumes of nickel, chromium compounds, arsenicals, asbestos, coal tar, soot, vapors or mists of

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Public Health MONOGRAPH

No. 36

The accompanying article discusses the principal findings presented in Public Health Monograph No. 36, published concurrently with this issue of Public Health Reports. The author is head of the Environmental Cancer Section of the National Cancer Institute, National Institutes of Health, Public Health Service.

Readers wishing the data in full may purchase copies of the monograph from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. A limited number of free copies are available on specific request to the Public Inquiries Branch of the Public Health Service. Copies will be found also in the libraries of professional schools and of the major universities and in selected public libraries.

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Hueper, W. C.: A quest into the environmental causes of cancer of the lung. Public Health Monograph No. 36 (Public Health Service Publication No. 452). 54 pages. Illustrated. U. S. Government Printing Office, Washington, D. C., 1955. Price 45 cents.

isopropyl oil, certain cancer-producing petroleum derivatives, and radioactive ores and gases. Significant amounts of recognized cancer-producing chemicals, moreover, have been demonstrated in the exhaust of gasoline or diesel engines and in the atmospheric pollutants of English and American cities. They are contained also in the dust of asphalted roads and in the carbon black constituting a considerable component of automobile tires. The number, variety, and amounts of cancer-producing contaminants of the general and occupational environment have grown during recent decades with the development of modern industry and the increased use of industry-related products. Numerous epidemiological observations strongly suggest that industry-related factors have played an important causal roll in the rise of lung cancers in the industrialized countries of the Western World observed during the last 50 years.

Epidemiology

The general epidemiological evidence supporting this concept is as follows: While a real, definite, and progressive rise in lung-cancer frequency has been noted since the turn of the century, this development revealed marked variations in its time of onset, in its relative degree, and its progression rate in different countries and localities. In some countries, a rise in lung cancer death rates did not become apparent until after 1930 (Denmark, Norway, Italy). In others, and particularly in highly industrialized countries (Germany, Switzerland, England), this change was demonstrable soon after 1900.

English, German, Austrian, and American observations show consistently and significantly higher lung cancer death rates for inhabitants of urban-industrialized areas than those prevailing for rural areas.

Industrial life insurance male policyholders coming from low-income groups and engaged in manufacturing, mining, transportation, and other occupations with possible and often specific respiratory health hazards were found to have lung cancer rates which were 30 to 50 percent higher than those present for general policyholders, mainly composed of white-collar workers and the self-employed.

There was not only a marked irregularity in the progression rates of lung cancer deaths and morbidity for 10 different metropolitan areas in the United States, according to surveys made in 1937 and 1947, but the annual lung cancer death progression rates in the United States were higher for 1914–30 than for 1931–44. Allowing a 20-year latent period, one would expect that the progression of the death rate in recent years would be much higher than in the early period, if cigarette smoking would represent a major causal factor in the rise of lung cancer frequency.

Considering the remarkable variations in the male-female sex ratio at different times, in different localities and different demographic groups ranging even during recent years from 1:1 to 50:1, it is most unlikely that such discrepancies and changes are attributable to fluctuations in the intensity of one single factor, such as cigarette smoking, but appear to be due to alterations in the type and extent of action of a broad spectrum of environmental carcinogenic agents affecting the members of the two sexes to different degrees. Men are for occupational and environmental reasons more intensely and consistently exposed to a variety of known environmental cancer-producing atmospheric pollutants than women.

The various lung cancer-causing agents elicit lung cancers of various structural types. No special type of lung cancer is characteristic for any special carcinogenic factor. None of the main structural types was rare at any time or has any exclusive connection with cigarette smoking.

There does not seem to exist any parallelism between the lung cancer death rate and the per capita consumption of cigarettes for different countries. In fact, the rise in lung cancer death rates parallels as closely, or even more closely, the rise in production and/or consumption rates of motor fuel, coal tar, petroleum products, and several carcinogenic metals and minerals, or the construction of asphalted roads, than that of cigarettes.

Industry-Related Factors

Occupational and epidemiological investigations present additional circumstantial evidence

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in support of industry-related factors as important causal agents in the production of lung cancer.

An analysis of lung cancer frequency among members of seven large industrial groups lists nonferrous metal workers with the highest rate, followed by transportation workers, while farm laborers have the lowest rate. Other investigations indicate that workers exposed to soot from coal- or oil-burning furnaces or powerplants, to metal fumes and dusts or arsenicals, have excessive lung cancer death rates. Included in these occupational groups are operating railroad workers, engineers, stokers, chimney-sweeps, oilers, furnacemen, mechanics, welders, polishers, patent fuel workers, marine engineers, wipers, foundry workers, gashouse workers, tar workers, road workers and asphalters, sheet-metal workers, boilermakers, crane operators, smelter workers, molders, boiler scalers, lathe workers, iron ore miners, grain dockers. Since the total number of members of such occupational groups is considerable, it cannot be maintained that occupational cancer hazards account for only an insignificant portion of the total lung cancer deaths. It is, moreover, evident that abnormal occupational lung cancer hazards seem to exist only for certain groups of workers and that for this reason they must be related to exposures to definite, specific, and identifiable substances. There is scarcely any likelihood that such occupational differences in lung cancer liability are attributable to fundamental differences in cigarette smoking habits between members of the various occupational groups.

Occupational Groups

Occupational cancers of the respiratory organs (lung, larynx, nasal cavity, and nasal sinuses) provide conclusive evidence of the existence of industry- and occupation-related respiratory cancer hazards for members of well-defined worker groups having contact with specific agents.

Such respiratory cancer hazards have been demonstrated for retort workers of gas manufacturing plants and coke ovens, for workers employed in crude paraffin oil pressing operations, for isopropanol manufacturers, for nickel refinery workers, chromate manufacturers and chrome pigment handlers, for arsenical insecticide producers and users, for asbestos workers, and radioactive ore miners. The lung cancer attack rates for members of these occupational groups are many times those found for the general population of same age and sex. While the great majority of the victims of occupational respiratory cancer are males, because only males are employed in most of these hazardous occupations, whenever females also were employed, such as in the asbestos industry, and have the same type and a similar degree of exposure, there is a trend toward an equalization of the lung cancer attack rates for the two sexes.

Exposures to occupational respiratory cancer-producing agents are sometimes characterized by a typical symptom complex involving not only the respiratory organs but also other tissues and organ systems. The symptom complex related to coal tar cancer provides a striking illustration of the value of this type of medical evidence in support of a specific etiology of a lung cancer.

Medical evidence amply attests to the fact that contact of the skin with coal tar pitch, asphalt, soot, creosote, and tar oils has been responsible for several thousand cases of occupational cancer of the skin, scrotum, and lip. There are, moreover, important cutaneous stigmata characteristic of occupational contacts with these products. These manifestations form a well-defined symptomatic coal tar cancer pattern consisting of chronic dermatitis, comedones, folliculitis, hyperpigmentations of the skin, leukoderma, cutaneous atrophies, warts, papillomas, cornified horns, and light hypersensitivity. Since respiratory exposure to coal tar fumes always entails also cutaneous contact with this material, pathological symptoms from both the cutaneous and respiratory systems combine in the composition of the symptom complex elicited by exposure to coal tar and related problems.

In my opinion, the medical evidence supporting a major role of cigarette smoking in the causation of lung cancer, on the other hand, is inadequate. It is surprising to note the absence of positive statistical associations between lung cancer and cigarette cough, although this latter symptom is clinically characteristic of chronic chain smokers. Despite the fact that

the lips and oral mucosa are constantly bathed in the tarry liquor oozing from the tip of the cigarettes and despite the contact of these parts with the smoke coming from the cigarettes, there is no statistical association with cancer of these parts.

The claim that no tarry material exudes from the cigarette tip cannot be taken seriously, considering the well-known fact that chronic cigarette smokers have notoriously dark-brown-stained fingers. There is, on the other hand, not a single case of cancer of the fingers attributable to cigarette tar available, which would form the equivalent to the numerous cases of coal tar cancers of the hands placed on record. Such a lack of confirmatory medical evidence cannot conveniently be disposed of by assuming a specific "immunity of the skin of the first three fingers" to tobacco tar.

The claimed absence of a positive association between lung cancer and the habit of inhaling cigarette smoke also is inconsistent with the rule that the incidence rate of occupational cancers increases with the intensity of exposure to a carcinogen. The medical considerations on cigarette-smoke cancer of the lung thus reveal a number of serious and fundamental defects and contradictions.

Carcinogenicity of Industrial Agents

Experimental investigations have furnished ample proof of the carcinogenicity of many of the agents involved in the production of human respiratory cancer of occupational origin.

Such an experimental evidence is available for coal tar, pitch, soot, various mineral and petroleum oils, nickel, and radioactive substances. For the carcinogenic action of constituents of coal tar there exists for instance, a large mass of experimental observations made on various species, such as mice, rats, rabbits, dogs, and chickens. Specific carcinogenic polycyclic hydrocarbons, moreover, have been isolated from coal tar and pitch, soot, mineral oils, and carbon black, and such findings have been confirmed by various investigators.

The experimental evidence concerning a carcinogenic action of tobacco tar, on the other hand, is remarkably uncertain. There exists a considerable discrepancy in the observations made by various investigators as to its carcinogenic action on mice and rabbits. While the majority either did not find any or a very mild carcinogenic effect when tobacco tar was applied to the skin of mice or rabbits, two groups of investigators reported remarkable results in this respect. It is rather disconcerting that the latest of these reports made only a year ago could not be confirmed by subsequent investigators using a similar technique and time of application of the tobacco tar to the skin of mice.

The best that can be said about the experimental evidence on hand regarding carcinogenic properties of tobacco tar is that it indicates the presence of mildly carcinogenic agents in cigarette tar through the use of hyper-reactive animals. There is no evidence that these observations of the skin of a strain of selectively inbred mice have any equivalent in man. Thus the practical importance of these observations as to cancer of the human lung is at present uncertain.

Conclusions

1. The total epidemiological, clinical, pathological, and experimental evidence on hand clearly indicates that not a single one but several if not numerous atmospheric pollutants are to a great part responsible for the causation of lung cancer.

2. The available data do not permit any definite statements as to the relative importance of the various recognized respiratory carcinogens in the production of cancers in the general population. Additive, cumulative, and synergistic effects of several of such agents are a distinct possibility.

3. Observations on occupational respiratory cancers, on the other hand, indicate that in restricted occupational groups exposed to well-defined and highly potent respiratory carcinogens all or most of the respiratory cancers found are attributable to one single carcinogenic air pollutant.

4. The widespread presence of industry-related atmospheric pollutants of recognized carcinogenic properties suggests that the recent alarming rise in lung cancer frequency espe-

cially among males may in part be causally related to the local and general development of modern industry and the use of its products.

5. While it is possible that cigarette smoking has played a contributory role in this respect, the total evidence available if critically evaluated does not favor the concept that cigarette smoking represents a major factor.

6. Since extensive and expensive efforts are required for obtaining an effective preventive control of the existing respiratory cancer hazards, rigid measures should be taken to discourage the introduction of new atmospheric air pollutants of carcinogenic type, especially if they are of the general environmental variety which are most difficult to control.

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Preliminary Report

Epidemic Outbreak of Poliomyelitis in Puerto Rico

By JUAN A. PONS, M.D.

SINCE the establishment of poliomyelitis as a clinical entity in Puerto Rico in 1928, sporadic cases have been reported each year uniformly throughout the island, without significant concentration of cases, except for the years 1942 and 1946, when the disease assumed epidemic proportions, with 117 and 307 cases, respectively. An annual average of 50 cases has been recorded during the last 10-year period. A total of 31 cases with 4 deaths, uniformly distributed among 18 municipalities, was reported during the year 1953. In 1954, considerable poliomyelitis was present in Trinidad, Haiti, and Jamaica, and the epidemic in Puerto Rico was probably part of the larger situation throughout the West Indies.

Data collected by the bureau of transmissible diseases control and by the bureau of crippled children of the Puerto Rico Department of Health have been combined and used in the preparation of this preliminary report of an epidemic of poliomyelitis in Puerto Rico.

During the year 1954, up to the end of the month of October, only 21 cases of poliomyelitis, with no deaths, had been recorded for Puerto Rico. Then, in November, a sudden upsurge in the incidence of the disease took place in the municipality of Toa Baja, which has a total rural population of 13,937 (1950 census). During a period of a little more than 1 month, 27 cases, including 4 deaths, occurred in rapid succession in a semirural area of 7,000 inhabitants, and the epidemic soon spread to the surrounding territory. Forty cases, with 5 deaths, all among residents of rural areas, occurred in the entire municipality, an attack rate of 287 cases per 100,000 rural population.

The epidemic was soon felt in adjacent municipalities and in the relatively distant municipality of Arecibo, as follows:

Municipality	*Total cases*	*Deaths*
Bayamon	30	3
Catano	31	4
Toa Alta	6	1
Rio Piedras	14	0
San Juan	21	1
Trujillo Alto	5	0
Juncos	4	0
Arecibo	22	1
Total	134	10

The epidemic form of the disease appeared in these municipalities in a chronological order that bore a close relation to their distance from the first center of dissemination. Scattered cases, which showed no tendency to epidemic concentration, have occurred in various other municipalities, to bring the total poliomyelitis cases for Puerto Rico during the 3-month period November 1, 1954–January 31, 1955, to 218 cases, including 16 deaths.

Besides its characteristic clinical manifestation, the disease has been confirmed by autopsy findings and by isolation of the virus. Through the cooperation of the United States Army Tropical Research Medical Laboratory at San Juan, P. R., type I (Brunhilde) virus has been

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Table 1. Municipalities in Puerto Rico in which poliomyelitis was recorded during the period Nov. 1, 1954–Jan. 31, 1955

Municipality	Population	Number of cases	Rate per 100,000 inhabitants	Municipality	Population	Number of cases	Rate per 100,000 inhabitants
Aibonito (5)	18, 191	1	5. 5	Luquillo (44)	9, 967	1	10. 0
Arecibo (7)	75, 361	22	29. 2	Manatí (45)	30, 449	2	6. 6
Barranquitas (10)	17, 605	1	5. 7	Moca (49)	21, 614	1	4. 6
Bayamón (11)	48, 000	30	62. 5	Morovis (50)	19, 291	1	5. 2
Caguas (13)	60, 132	2	3. 3	Naguabo (51)	21, 019	2	9. 5
Carolina (15)	29, 224	1	3. 4	Naranjito (52)	15, 927	3	18. 8
Cataño (16)	19, 865	31	156. 0	Ponce (56)	126, 810	1	. 8
Comerío (22)	17, 966	1	5. 6	Río Grande (59)	16, 651	1	6. 0
Corozal (23)	23, 087	4	17. 3	Río Piedras (60)	143, 989	14	9. 7
Dorado (25)	11, 749	1	8. 5	San Juan (64)	224, 767	21	9. 3
Guaynabo (30)	29, 120	5	17. 2	San Lorenzo (65)	29, 248	1	3. 4
Gurabo (31)	16, 395	2	12. 2	Toa Alta (68)	14, 155	6	42. 4
Hatillo (32)	20, 877	3	14. 4	Toa Baja (69)	15, 761	40	253. 8
Humacao (34)	34, 853	3	8. 6	Trujillo Alto (70)	13, 605	5	36. 8
Juncos (38)	21, 654	5	23. 1	Villalba (75)	14, 972	1	6. 7
Lares (40)	29, 951	2	6. 7				
Las Piedras (42)	16, 208	1	6. 2	Total	1, 233, 218	218	17. 7
Loíza (43)	24, 755	3	12. 1				

NOTE: Figures in parentheses refer to key number of municipality (see map).

isolated in two different specimens of brain tissue collected at autopsies.

Table 1 shows, by municipalities, the distribution of cases of poliomyelitis in Puerto Rico and the corresponding incidence rate per 100,000 population during the 3-month period of the study. The incidence rate is more graphically expressed in the accompanying map. The chart shows the weekly distribution of cases throughout the year 1954 and the first weeks of 1955.

The urban and rural distribution of cases and the corresponding composition of the general population exposed is shown in table 2. The distribution of cases corresponds almost exactly to the urban-rural distribution of the exposed population.

Table 2. Urban and rural distribution of cases of poliomyelitis and corresponding distribution of the general population exposed, Nov. 1, 1954–Jan. 31, 1955

Residence	Cases		Population [1] exposed	
	Number	Percent	Number	Percent
Total	218	100. 0	1, 074, 475	100. 0
Urban	115	52. 8	571, 699	53. 2
Rural	103	47. 2	502, 776	46. 8

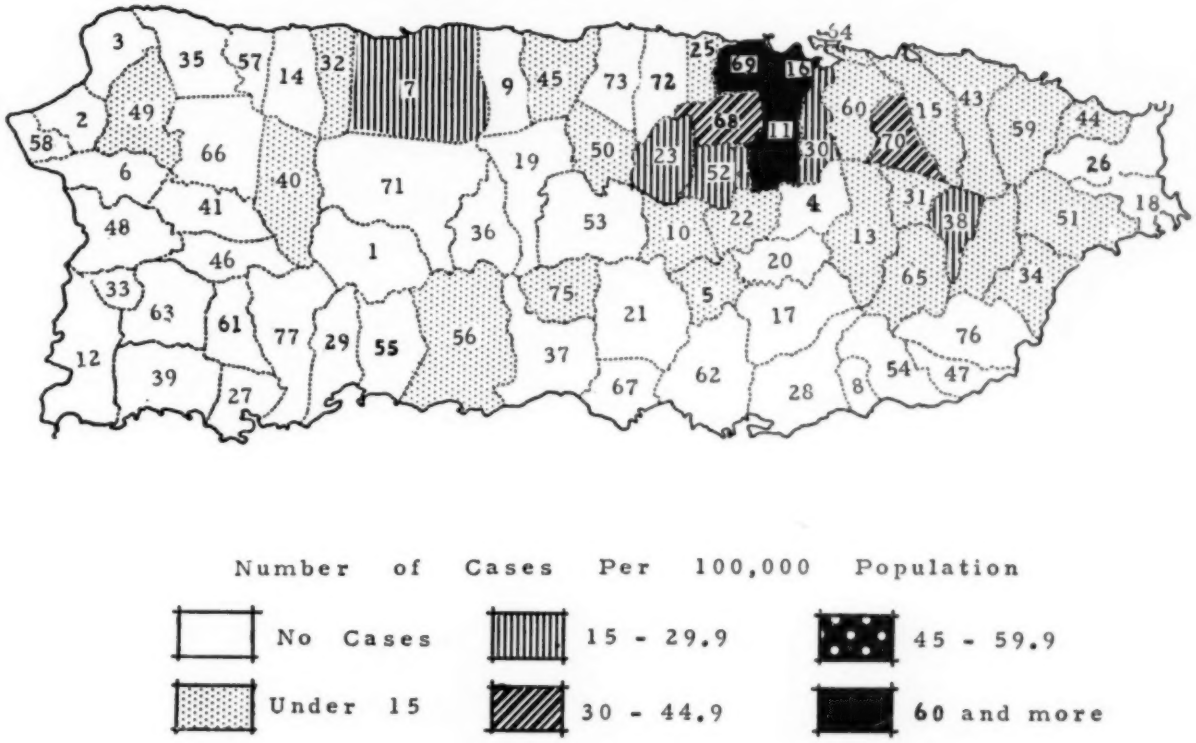
[1] 1950 census.

Table 3. Confirmed cases of poliomyelitis in Puerto Rico recorded during the 3-month period Nov. 1, 1954–Jan. 31, 1955, according to age and sex

Age groups	Sex			Percent in each age group	Cumulative percentage
	Male	Female	Total		
Total	120	98	218	100. 0	
Under 6 months	6	5	11	5. 0	5. 0
6–12 months	17	12	29	13. 3	18. 3
1–2 years	60	47	107	49. 1	67. 4
3–4 years	20	24	44	20. 2	87. 6
5–9 years	12	9	21	9. 6	97. 2
10 years and over	5	1	6	2. 8	100. 0

Table 3 shows the age and sex distribution of cases recorded during the period November 1, 1954–January 31, 1955. This age distribution is remarkably similar to the age distribution during the previous epidemics in 1942 (*1*) and 1946 (*2*) and follows closely the usual pattern

Distribution of poliomyelitis cases in Puerto Rico, by municipalities, during the 3-month period November 1, 1954–January 31, 1955



of age distribution characterizing tropical epidemic poliomyelitis. Five percent of the cases occurred in children under 6 months of age, and practically 90 percent belong to the age group under 5 years, with especially marked concentration in children under 2 years of age (68 percent). Only 6 cases, or less than 3 percent, occurred in persons aged 10 years and over.

Table 4. Confirmed cases of poliomyelitis in Puerto Rico during the 3-month period Nov. 1, 1954–Jan. 31, 1955, according to severity of involvement

Severity	Cases	
	Number	Percent
Total	218	100.0
Severe [1]	103	47.2
Mild [2]	71	32.6
Cured [3]	18	8.3
Died [4]	16	7.3
Not specified [5]	10	4.6

[1] Involvement of one or more extremities, with paralytic manifestations. [2] Absence of paralysis. Muscular debility of one or more groups of muscles only. [3] No residual paralysis or muscular weakness. Includes abortive and spontaneous complete recoveries. [4] Severe cases terminating in death. [5] Data not available. Mostly cases treated at home by private physicians.

Table 4 shows the classification of cases according to the severity of involvement, based on preliminary evaluation at the termination of the acute stage of the disease.

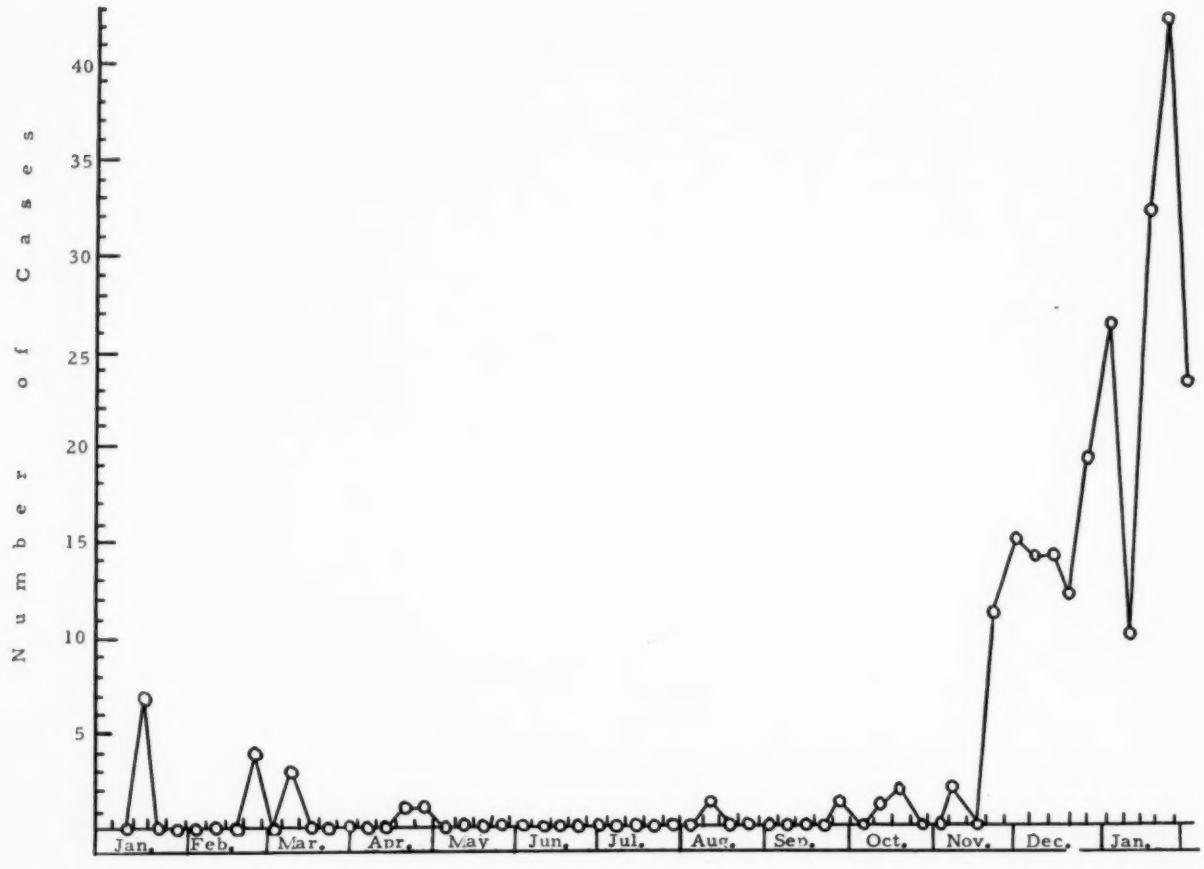
Aiming at uniformity of classification of cases according to severity of involvement, after due consideration and discussion by pediatricians and orthopedic surgeons, the following classification was selected: severe, mild, cured, died, and not specified. The number of cases in each of these groups (table 4) is summarized below, according to whether the cases were paralytic or nonparalytic.

Severity	*Number*	*Percent*
Paralytic	[1] 119	54.5
Nonparalytic	[2] 89	40.9
Not specified	10	4.6

[1] 103 cases; 16 deaths. [2] 71 mild; 18 abortive.

From the very beginning of the outbreak, control measures were taken. These consisted

Weekly number of confirmed cases of poliomyelitis in Puerto Rico during the calendar year 1954 and January 1955



chiefly in encouraging early diagnosis, with competent free consultation services at all times to private physicians by pediatricians and orthopedic surgeons of the department of health; prompt hospitalization in our district hospitals of suspicious or confirmed cases during the acute stage for observation, confirmation of diagnosis, and proper treatment, with subsequent followup treatment of residual paralysis or muscular weakness at the termination of the acute stage in a convalescent hospital with specially trained personnel and without limitation of hospitalization period required by each individual case; and followup observation of home cases in our diagnostic and plastic clinics.

Gamma globulin has been administered to familial and other intimate contacts under 10 years of age of known poliomyelitis cases, and general instructions frequently have been given to the public through the daily press and radio programs.

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(*1*) Sheplan, L. B., and Trelles, B. H.: Infantile paralysis in Puerto Rico. Puerto Rico J. Pub. Health & Trop. Med. 19: 120–131, September 1943.

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